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Fire Alarm System/Fire Suppression System for Mobile Tactical Shelters

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The objective of this project was to develop a fire detection/suppression capability for DOD standard family mobile tactical shelters. The systems developed and tested provide complete protection during all employment conditions; in garrison use, storage, transportation, and deployed field conditions. The reports outlines the requirement and the test and evaluation program. Two manufacturers of detection systems and two manufacturers of suppression systems were identified and qualified to meet the fire protection requirements for mobile tactical shelters. Keywords include:

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PREFACE

This report was prepared by Columbia Research Corporation for the Headquarters Air Force Engineering and Services Center, Engineering and Services Laboratory, under support contract #FO8637 84 M2142.

This report summarizes work done between December 1983 and May 1985. Captain Fred K. Walker was the Air Force Project Officer.

The project was jointly funded by Headquarters Electronic System Division, Shelter Management Office; Headquarters Electronic Security Command, Engineering and Services Directorate; and Headquarters Engineering and Services Center, Engineering and Services Laboratory. ANSUL Fire Protection Wormald U.S. Inc., Marinette, WI and FENWAL Inc., Ashland, MA provided engineering assistance, prototype systems, and test agent (HALON 1301) at no cost to the government; this support was instrumental in the successful program completion.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). Through NTIS it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

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SECTION I

INTRODUCTION

A. OBJECTIVE

The objective of this research effort was to test and evaluate candidate fire detection/alarm and fire suppression systems for mobile tactical shelters.

B. BACKGROUND

1. General

The U.S. Air Force needs tactical mobile shelters to enhance its capability to deploy tactical air units. The shelter acquisition plan is based upon purchase of containers built to International Standards Organization (ISO) specifications for sealift type, container-ship use. These 8-foot wide, 8-foot high, and 20-foot long containers will be constructed with specific exterior features such as ISO fittings, skids, forklift pockets, etc.

Basic empty containers with doors and air condition/heat pump access panels are purchased from a commercial contractor. The container interiors are custom-built and mission equipment is installed. The Navy has used these container shelters for complete self-contained aircraft maintenance operations, communications operations and maintenance, personnel quarters, prime power systems, and other uses.

At present, the Air Force is having a prototype mobile tactical shelter built for F-16 intermediate maintenance operations. The shelter facility program will be expanded to include other aircraft in later acquisitions. Air Logistics Command has estimated a requirement for approximately 3000 shelters.

2. Fire Protection Requirements

When deployed, mobile tactical shelters will house high-value, mission-essential equipment such as electronic data processing (EDP), avionics test equipment, technical manuals and records, and other items dedicated to support the tactical mission. The Air Force is involved in providing adequate fire protection for these mobile facilities and their mission-essential contents. Fire protection requires a system that will protect an individual tactical shelter and its contents from catastrophic fire damage. Such a fire protection system must detect a fire, activate an alarm both inside and outside the shelter, and effectively extinguish the fire. Typical shelter types and the quantity of Halon required to extinguish most probable types of shelter fires are shown in Appendix A.

C. SCOPE

The responses of one vendor-supplied detection/alarm system and two fire suppression systems were assessed, using three scenarios for each system. All tests involved controlled fires inside a fully instrumented test facility designed to simulate the mobile shelter. Personnel from AFESC's Engineering and Services Laboratory performed the tests at the USAF Computer Fire Test Facility on Tyndall AFB, Florida. Data derived from this effort will provide a basis for recommending optimal fire protection for mobile tactical shelters.

SECTION II

TEST FACILITIES AND EQUIPMENT

A. INTRODUCTION

This section describes the test facility and installed fire protection equipment. Detailed descriptions are provided for the permanent building utilized for the fire tests, the installed fire detection/alarm system, fire suppression systems, and the test equipment used for monitoring and data collection.

B. FIRE TEST FACILITY

1. Test Site

a. Building

A permanent building located at Tyndall Air Force Base, Florida, was used for the fire protection tests (Figure 1). The facility is constructed of reinforced concrete blocks with a reinforced concrete floor and roof. The building is approximately 50 feet long by 30 feet wide and contains six rooms separated by concrete block walls and connected by steel fire doors (Figure 2).

b. Fire Test Room

One room of the building was used for conducting the fire detection and suppression test. This room measures approximately 25 feet 6 inches by 16 feet by 8 feet and was chosen for conducting the fire tests because its volume approximates that of a double-wide tactical shelter. The room features a suspended panel ceiling and a vinyl tile floor. A double-wide steel door provides access from the outside with a single door for access to the room

from the inside. A set of windows was installed at the inside end of the room to permit observation of the fire tests from the instrumentation room.

Figure 1. Fire Test Building.

C. FIRE DETECTION/ALARM SYSTEM

1. Description

The fire alarm system, supplied by Monaco Enterprises, Inc., under Contract No. F0863784M0956, consists of a smoke detector, an alarm panel, signaling device, and 30 feet of hookup wire (Figure 3).

a. Alarm Panel (P/N 700-024-00)

This panel is a 6-inch by 6-inch by 3-inch sheet metal box enclosed with a side-hinged front panel containing the electronic supervisory boards for the detector and signaling device. Operating power for the alarm panel and signaling devices is provided from a 115/230 Vac supply or by four lithium batteries.

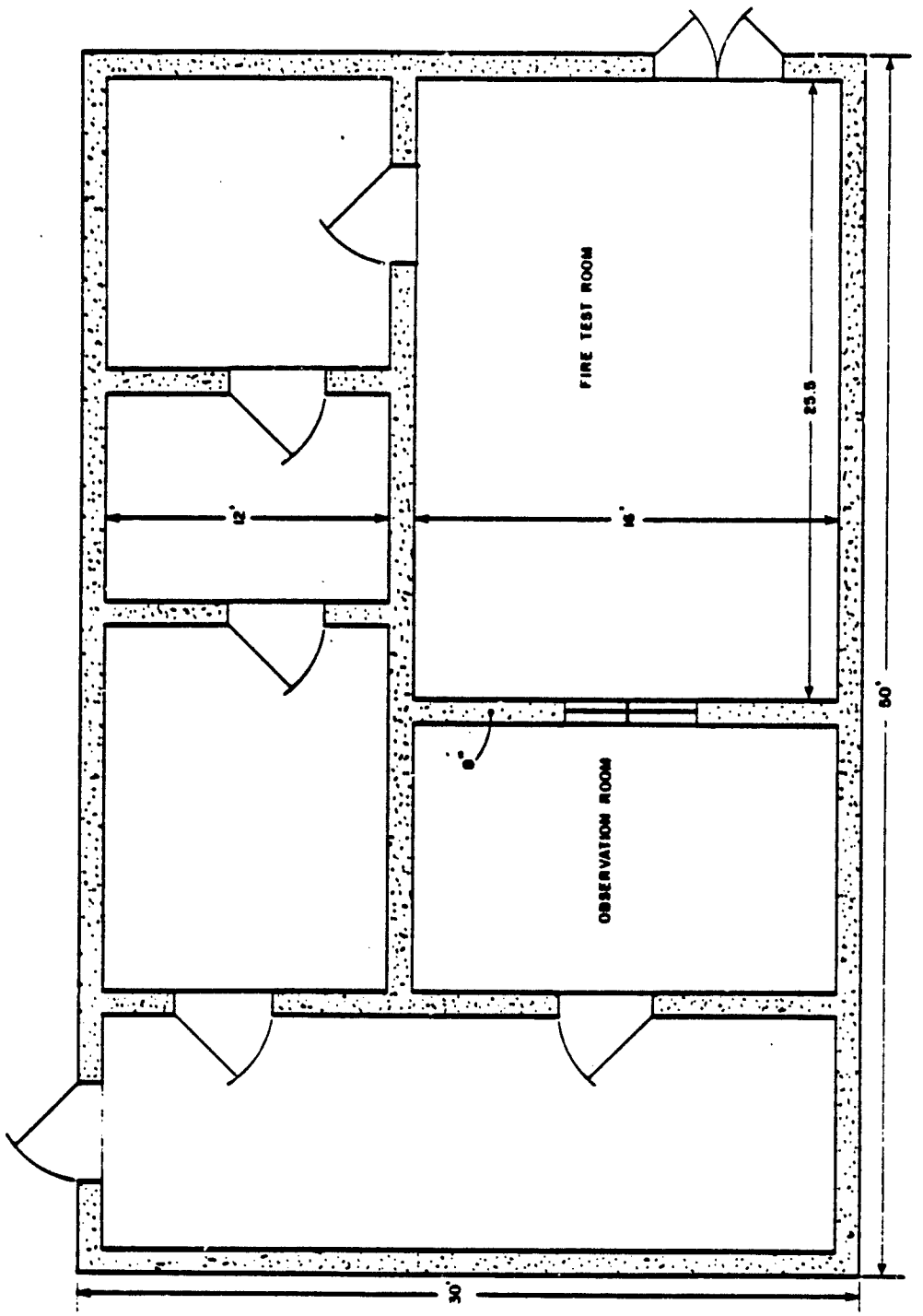

Figure 2. Building Floor Plan.

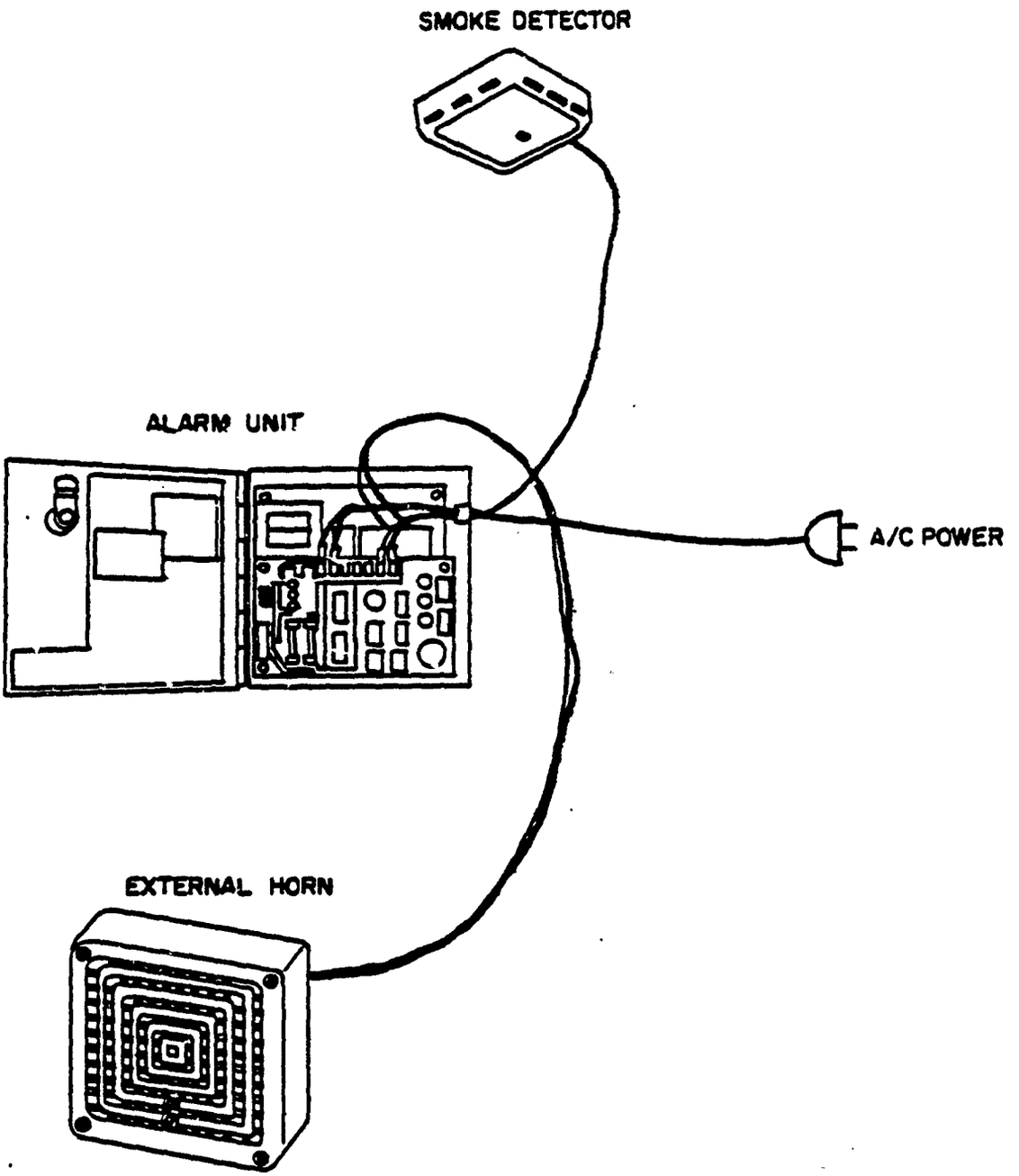

Figure 3. Monaco Fire Detection/Alarm System.

b. Smoke Detector (P/N 726-702-00)

The photoelectric-type detector operates on the light scattering principle. A visible indicator verifies that the detector is powered and a pushbutton permits a functional check. Power is provided by a standard 9 Vdc alkaline transistor battery.

c. Signaling Device (P/N 585-006-01)

The alarm used is a vibratone horn, producing sound caused by electromechanical vibration of a diaphragm. The horn can be silenced by the reset pushbutton in the alarm panel if the detector condition is normal.

D. FIRE SUPPRESSION SYSTEM

1. Introduction

Two competitive fire suppression systems were installed and functionally tested during consecutive periods of fire tests.

2. FENWAL System

This system consists of a release unit and Halon storage container (Figure 4).

a. Release Unit

The release unit is housed in a 6-inch by 6-inch by 3-inch metal enclosure with hinged front panel and contains the electronic circuit boards and batteries for actuation of the storage container discharge valve. Two cover-mounted switches permit the aborting or manual operation of the agent discharge.

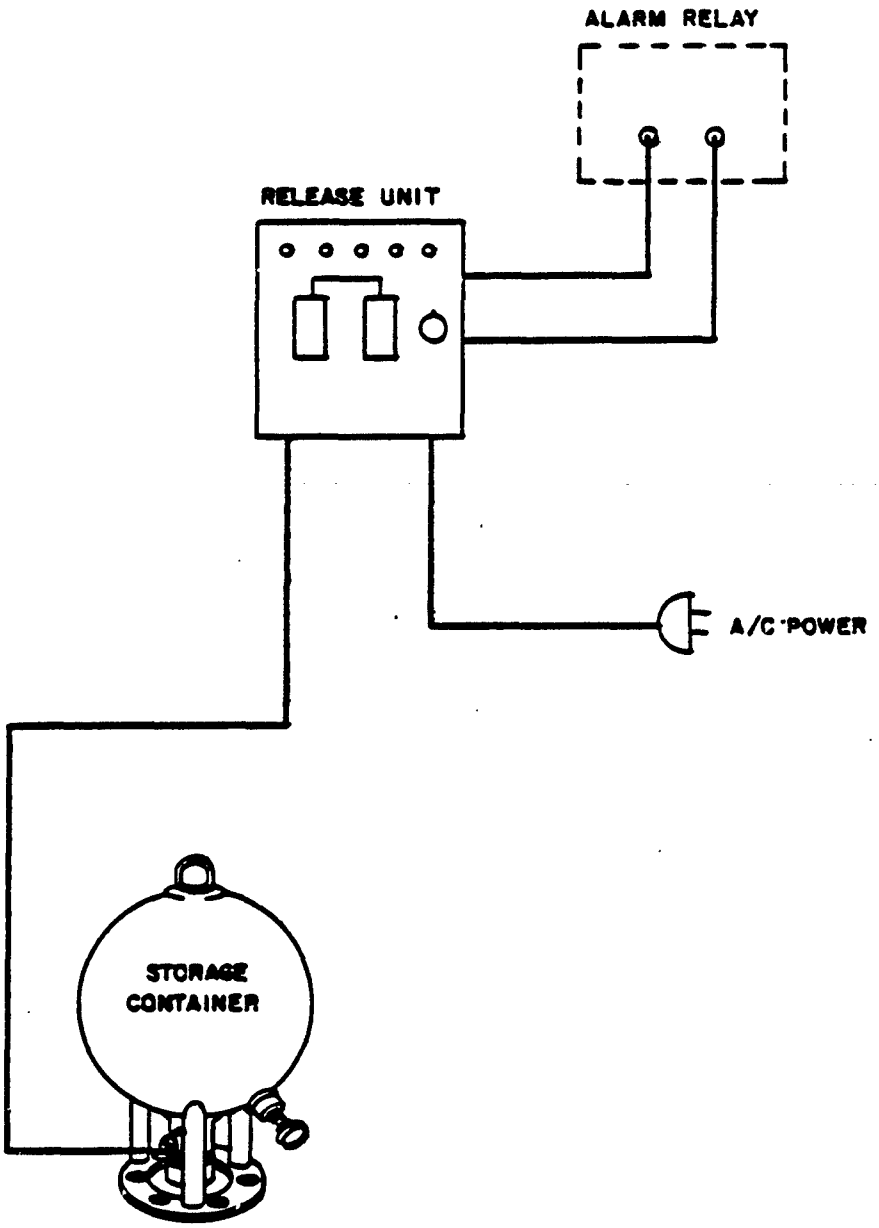

Figure 4. MANUAL Fire Suppression System.

b. Storage Container

The storage container is a spherical tank (17.3 inches diameter) for storing superpressurized Halon 1301. The unit comes equipped with a fill valve, pressure gage, a burst-disc-type discharge valve, a replaceable initiator well, and a screen assembly. Discharge of the container is accomplished by hydrostatic pressure from actuation of an electrically fired initiator which ruptures the burst disc of the exit valve. The container weighs approximately 52 pounds and is filled with 70 pounds of Halon 1301.

3. ANSUL System

The ANSUL fire suppression system consists of two control modules, a Halon storage container and a plug-in ac/dc converter (Figure 5).

a. Control Modules

The two 6-inch by 6-inch by 3-inch glass-filled nylon enclosures with removable covers are mounted on a plate for surface mounting. One module contains the electronic circuit boards, test/control push button and sonalert and the other module contains the discharge abort circuit and push button. The modules are powered by the ac-dc converter.

b. Storage Container

The storage container is a cylindrical tank 12 inches in diameter and 38 inches high for storing superpressurized Halon 1301. The container weighs 160 pounds and is filled with 90 pounds of Halon 1301. The unit comes equipped with a fill valve, pressure gage, and a pneumatically actuated discharge valve. Discharge of the container is accomplished by the release of the initiator plunger which opens a small valve and allows stored gas pressure to be applied to the main discharge piston. This pressure raises the valve, allowing the stored agent to discharge.

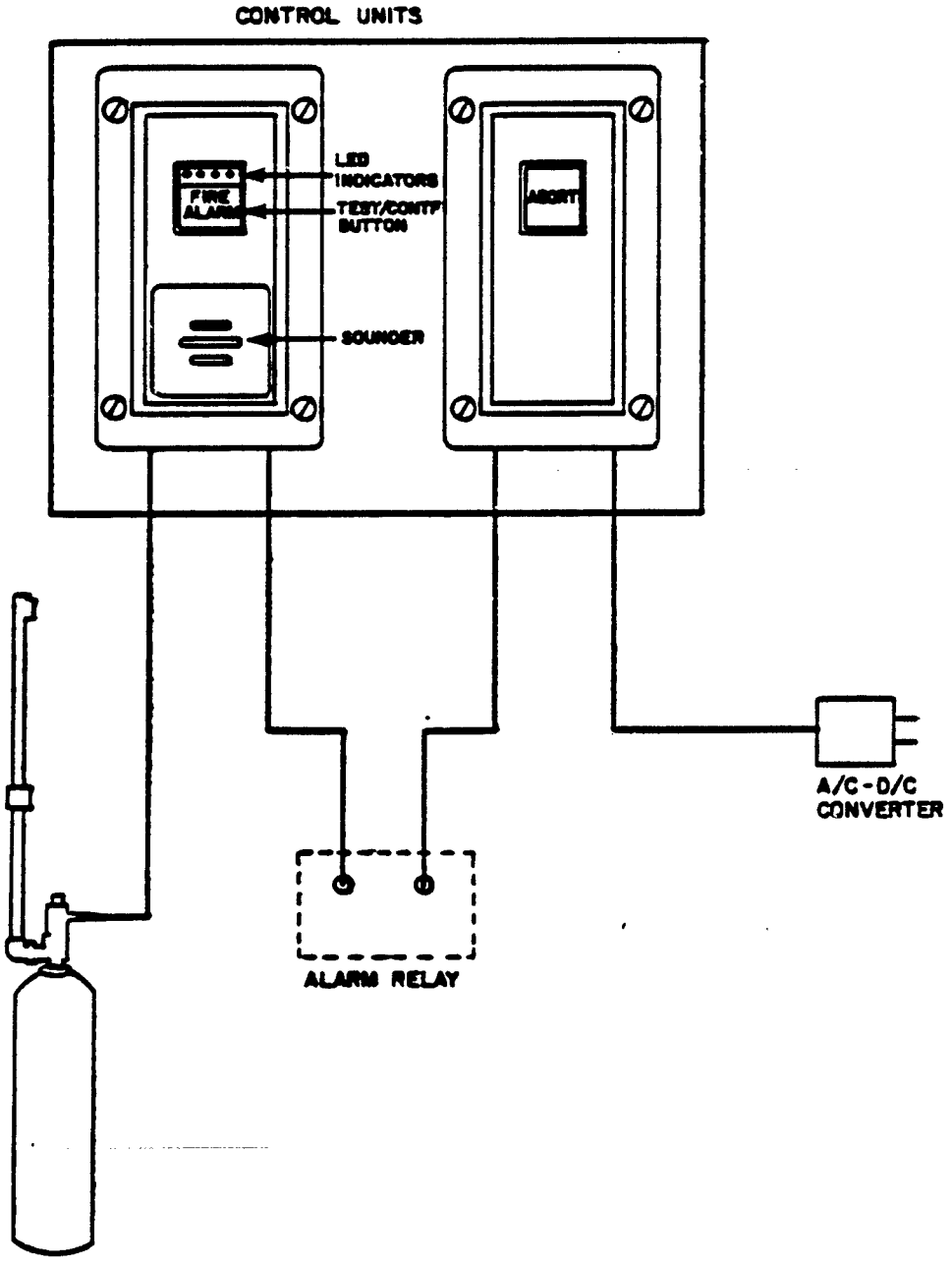

Figure 5. ANSUL Fire Suppression System.

E. INSTRUMENTATION

1. General

A data acquisition and recording system (Figure 6) was set up in tne observation room adjoining the fire test room to monitor and record test conditions. A Hewlett-Packard Model 3497A data acquisition/control was used to process the signals from the test equipment and smoke detectors and a Model 9826 was programmed to provide a 5-second sampling rate. Data were recorded on a Hewlett-Packard Model 2671G printer. Locations of sensing devices in the test room are shown in Figure 7.

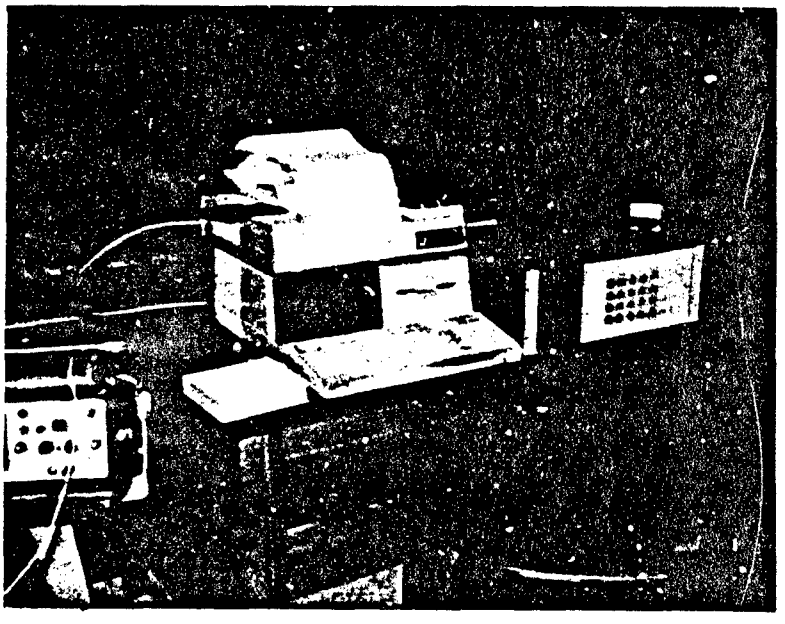

Figure 6. Data Acquisition and Recording Equipment.

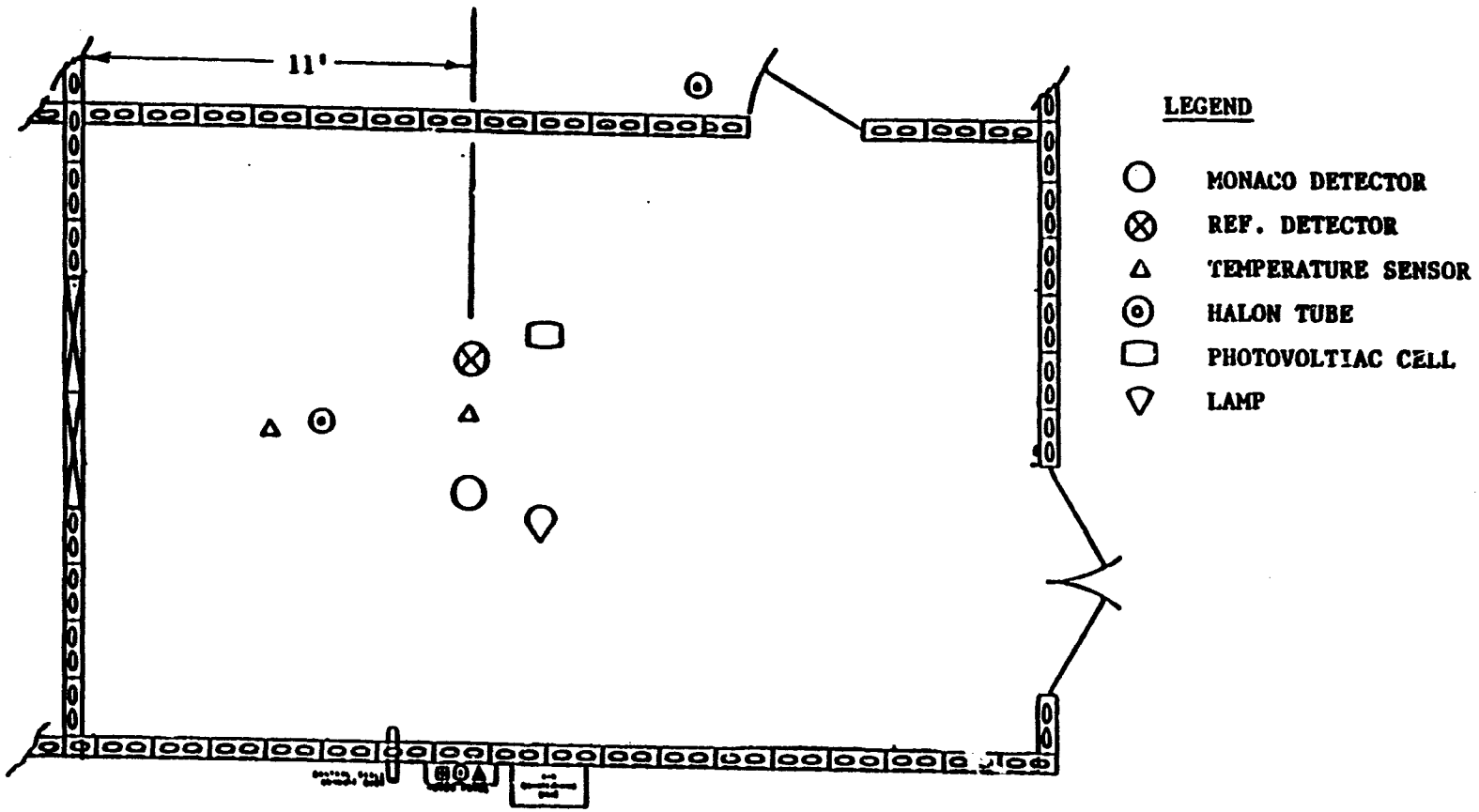

Figure 7. Location of Sensors.

2. Test Equipment

a. Sound Level Meter

A General Radio, Model 1933, sound-level meter was located outside of the fire test facility and positioned approximately 100 feet from the audible signaling device. The external output from the meter was used to provide an analog signal to the data acquisition unit.

b. Halon Analyzer

Using the thermal conductivity properties of Halon in air, a Perco Halon analyzer Model 113 (Figure 8) was used to sample concentration in the Fire Test Room. Two 50-foot sampling lines led from the analyzer located in the observation room into the Fire Test Room, and one 50-foot line led from the analyzer into a room adjoining the Fire Test Room. One Halor sampling point at the end of the lines was positioned 1 foot below the suspended ceiling and the other was located approximately 2 feet above the floor in the Fire Test Area. The end of the line in the adjacent room was positioned near the door, approximately 1 foot above the floor. Measurement of the Halon concentration by the Perco analyzer was supplied to the data acquisition module and recorded by the printer at 5-second intervals.

c. Temperature

Two thermocouples were positioned in the Fire Test Room to measure the air temperatures 3 feet from the test fire and approximately 1 foot from the smoke detectors.

d. Smoke Density

The visible smoke obscuration in the fire test room was measured by means of a dc-type milliameter, and a signal conditioning board in Hewlett-Packard data acquisition module. The milliameter was connected to a photovoltaic cell which was powered by a tungsten filament lamp energized by a

constant current source at approximately 2.4 Vdc. The photovoltaic cell and lamp are spaced approximately 5 feet apart (Figure 9).

The following equation is used to determine the percent of obscuration per foot.

$$O_u = \left[1 - \left(\frac{Ts}{Tc}\right)^{\frac{1}{d}}\right] 100$$

where

O_u = percent of obscuration per foot

T_s = smoke density meter reading with smoke

T_c = smoke density meter reading with clear air

d = distance in feet.

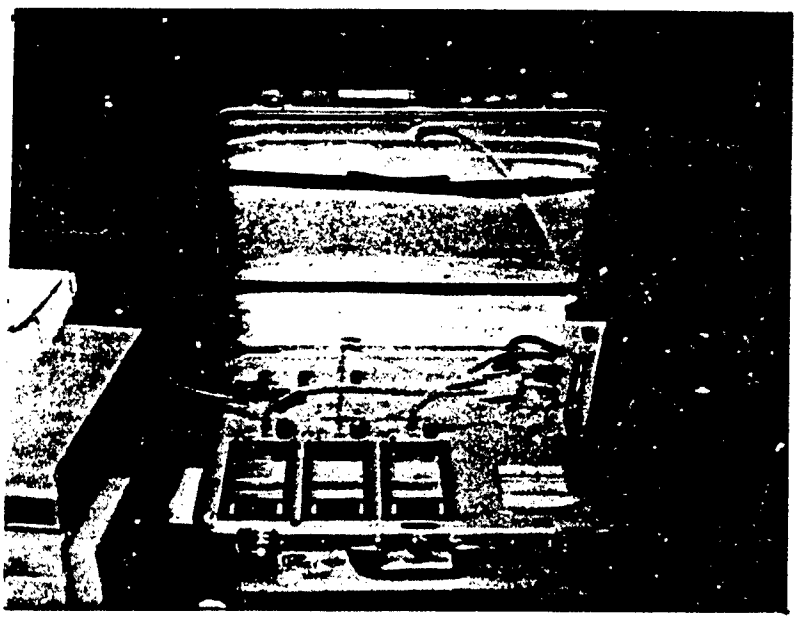

Figure 8. Halon Analyzer.

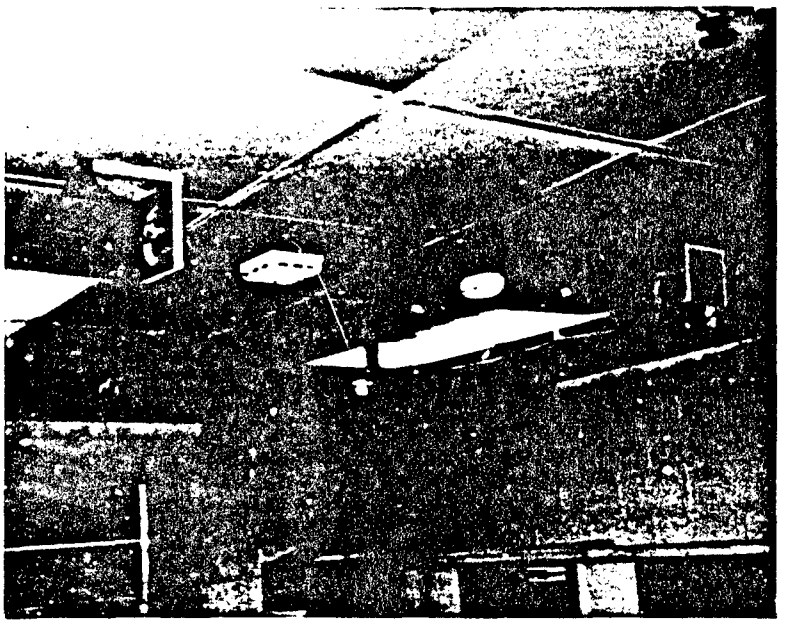

Figure 9. Photovoltaic Cell and Lamp.

SECTION III

TEST DESCRIPTION

A. GENERAL

The alarm control unit of the Monaco fire alarm system was installed in the fire test room and wired into the ceiling-mounted smoke detector and the outside signaling device.

An ionization-type smoke detector was installed on the ceiling, approximately 2 feet from the Monaco detector, to provide a comparison of the system response times.

Controlled fire tests were performed to obtain data to determine the compliance of the fire alarm/detection system to the Air Force Requirements letter (Appendix B). Subsequent fire tests were performed to evaluate two competitive fire suppression systems and their compliance with the Air Force Fire Suppression Requirements (Appendix C).

B. SMOKE TESTS

Fire tests were performed, using four combustible materials - paper, wood, gasoline, and polystyrene. All fires were initiated by an arc produced by a 10,000-volt transformer.

1. Paper Fire

Shredded newsprint, 1/4 to 3/8 inch wide by 1 to 4 inches long, was poured into a 4-inch diameter by 12-inch long sheet metal cylinder. The paper was tamped down and filling continued until the paper level was approximately 4 inches below the top of the cylinder. The filled container was then placed on a stand which positioned the bottom of the container about 2 feet above the floor (Figure 10). The tips of the ignitor were then placed at the bottom center of the container.

The ignition unit was activated and the paper ignited, a light smoke was produced which increased slightly but then decreased after approximately 90 seconds of operation. The paper was then reignited and the smoke output was increased. The reference smoke detector was activated when the smoke obscuration reached approximately 0.2 percent per foot, and the Monaco detector was activated when the smoke obscuration reached 2.08 percent per foot. Activation of the Monaco smoke detector activated the alarm unit and energized the external signaling device. The sound level produced at 100 feet was approximately 70 dB(A).

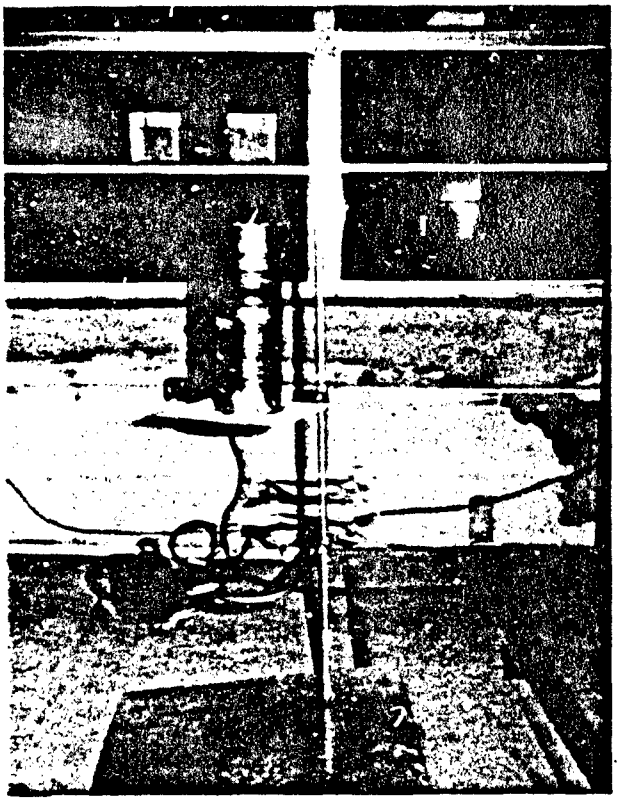

Figure 10. Paper Fire Setup.

2. Wood Fire

A wood brand formed of three layers of kiln-dried firestrips, each 3/4 inch square in cross section, 6 inches long, with six strips on each layer was used. The wood strips were nailed together, with adjacent layers at right angles to each other.

The wood brand was placed on the support on the fire stand, and a small can containing 4 milliliters of alcohol was placed on a support approximately 3 inches below the wood brand. The tips of the ignition units probes were placed in contact with the alcohol.

The ignition unit was activated and the alcohol ignited. Flames from the alcohol ignited the wood brand and a steady smoke buildup was observed (Figure 11). The reference smoke detector activated approximately 45 seconds after ignition at a smoke obscuration of 1.44 percent per foot. The Monaco smoke detector activated at 1 minute at a smoke obscuration of 4.85 percent per foot. The fire continued to burn for 4 minutes and the smoke obscuration increased to 26.2 percent per foot. The test was then stopped and the remaining combustibles removed from the fire test room.

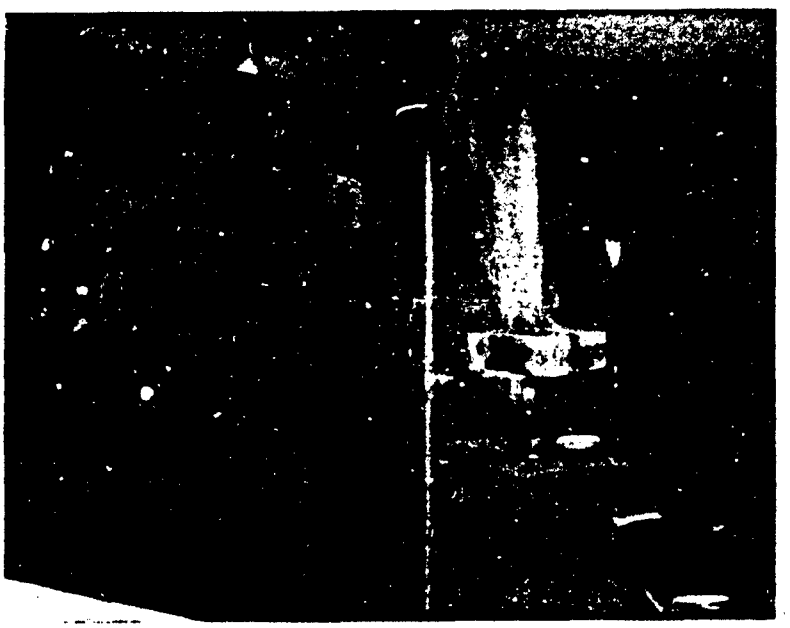

Figure 11. Wood Fire.

3. Gasoline Fire

Thirty milliliters of regular leaded gasoline were placed in a 6 1/4-inch diameter by 1 1/4-inch deep steel pan. The pan was then placed on the support on the fire test stand. The probe tips of the ignitor were then positioned above the lip of the pan for ignition of the gasoline vapors.

The ignition unit was activated and the gasoline ignited (Figure 12). The reference smoke detector was activated by the smoke 15 seconds after ignition at a smoke obscuration of 2.50 percent per foot. The Monaco detector was activated in 30 seconds after ignition at a smoke obscuration of 6.36 percent per foot. The smoke obscuration increased to 43.03 percent per foot after 3 minutes, at which time the gasoline was completely consumed.

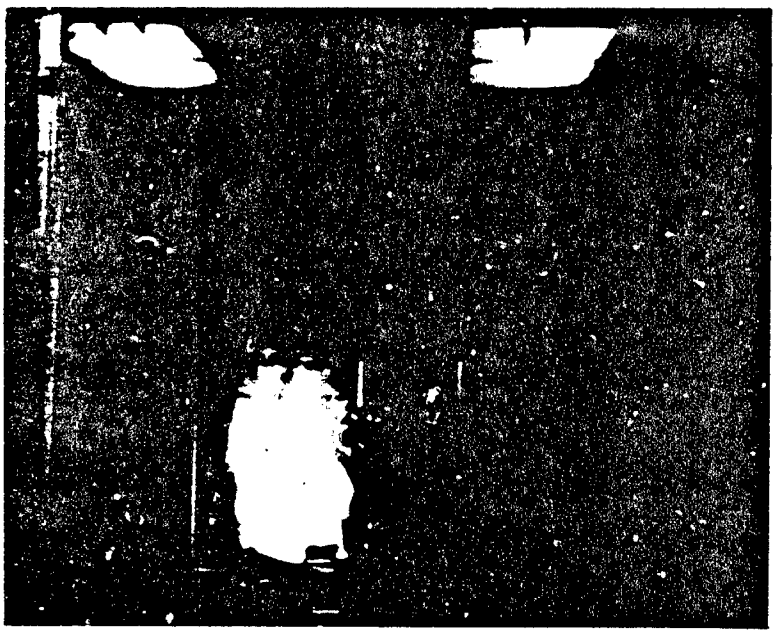

Figure 12. Gasoline Fire.

4. Polystyrene Fire

A receptacle, 6 inches in diameter by 18 inches long was formed from 1/4-inch mesh hardware cloth. The receptacle was then filled with polystyrene

packing material. The receptacle was then positioned on the support on the fire test stand, and a small container with 5 milliliters of alcohol was placed on a support approximately 3 inches below the polystyrene receptacle (Figure 13). The tips of the ignitor were positioned in the alcohol.

The ignition unit was energized and the alcohol ignited. The flame from the alcohol melted down the polystyrene chip, and the dripping liquid proceeded to ignite. The smoke obscuration increased slowly and activated the reference smoke detector after 30 seconds at an obscuration level of 1.44 percent per foot. The smoke intensity did not increase sufficiently to activate the Monaco smoke detector (maximum 3.66 percent per foot). The material was completely consumed and the fire self-extinguished in 2 minutes.

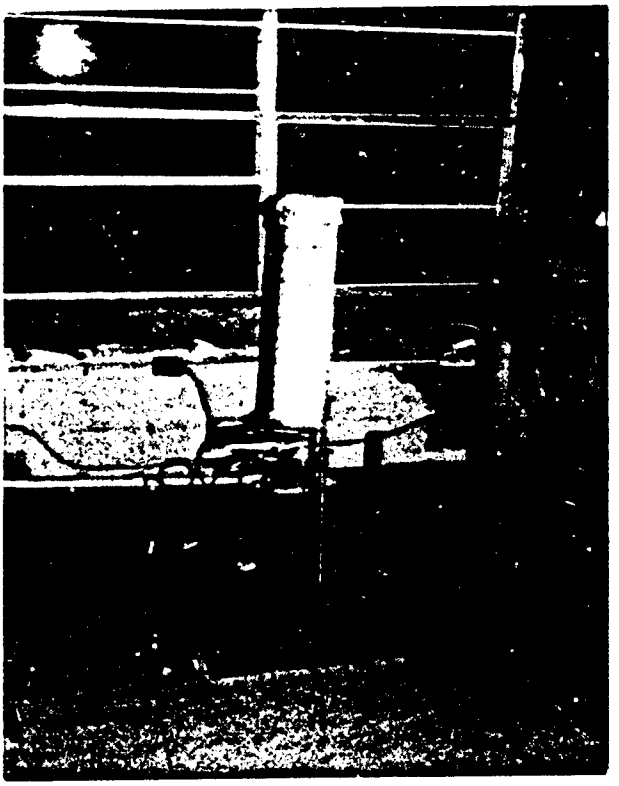

Figure 13. Polystyrene Fire Setup.

5. Wood Fire 2

The control unit of the Monaco alarm system was set up for operation on the internal batteries, and a wood brand was placed on the support of the fire test fixture. A small container with 4 milliliters of alcohol was placed on a support approximately 3 inches below the wood brand. The tips of the ignitor probe were placed in contact with the alcohol.

The ignition unit was energized and the alcohol ignited. The wood ignited and the smoke detector (Monaco) was activated at an obscuration of 4.85 percent per foot. The external signal device was activated and the sound level was measured as 66 dB(A).

C. FIRE SUPPRESSION TESTS

1. FENWAL System

A FENWAL fire suppression system, consisting of a control unit, Halon container, and initiator, was installed in the Fire Test Room and connected into the alarm relay (Figure 14). Three fire tests were then conducted, and data recorded during alarm activation and after the agent discharge. FENWAL fire suppression systems and parts lists are contained in Appendix D.

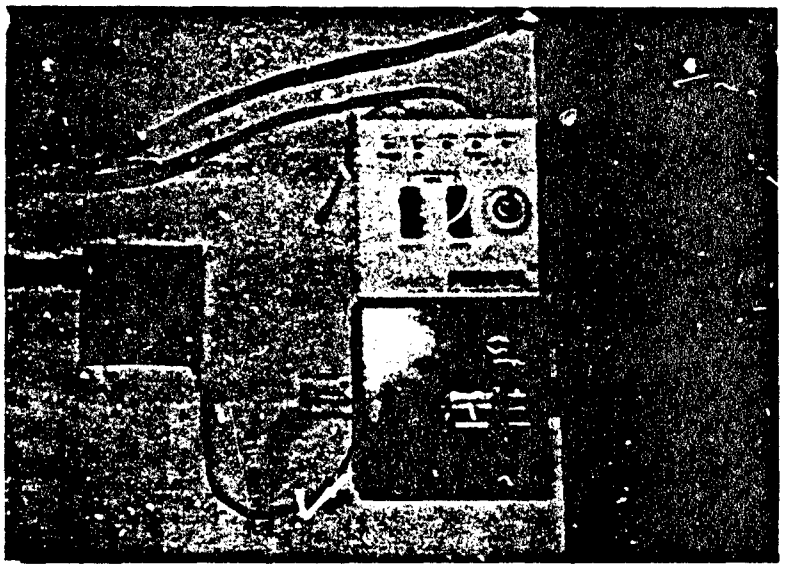

Figure 14. FENWAL Release Unit with Monaco Control Unit.

a. Test 1.

The Halon container was mounted on the support bracket, and the discharge from the container piped with 1 1/2-inch pipe and terminated with a pendant-type nozzle (Figure 15). A metal waste container was then filled with 2000 feet of magnetic computer tape and located 6 feet from the Observation Room window (Figure 16). The magnetic tape was ignited and the alarm system activated after approximately 40 seconds of burning. The initiator on the Halon container valve was activated approximately 30 seconds after the alarm activated. The agent discharged, and Halon concentrations in the fire test room were recorded at 5-second intervals. Halon concentration at the floor sampling location rose to 7.12 percent in 30 seconds after Halon discharge. At this time, the flame from the magnetic tape was completely extinguished; however, smoke continued to billow from the trash can and glowing embers were visible, indicating a deep-seated type of fire. Halon concentrations dropped steadily after the initial peaks and fell below 4 percent after 8 minutes. The magnetic tape continued to smolder; when the room was opened, the tape burst into flame.

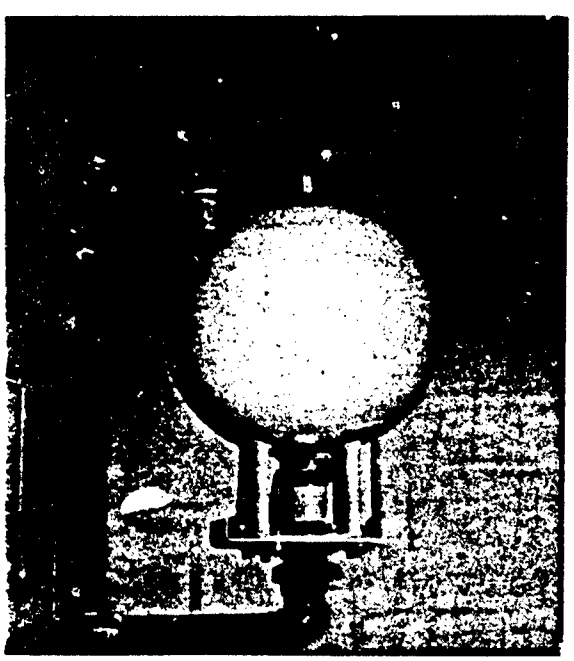

Figure 15. FENWAL Storage Container with Pendant Nozzle.

Figure 16. Waste Container with Magnetic Tape.

b. Test 2.

A new Halon container was installed in the support bracket and the discharge pipe with 1 1/2-inch pipe and terminated with a spiral nozzle (Figure 17). The door between the Fire Room and the adjoining room was opened and a transparent strip curtain door was installed on both sides of the opening. A pan containing a small quantity of gasoline was then placed on the support of the fire test fixture and ignited.

The Halon agent was discharged approximately 30 seconds after activation of the alarm unit. During the discharge period, the ceiling tiles near the container were lifted, and a large quantity of Halon was diverted into the space between the roof and suspended ceiling. A section of the suspended ceiling above the fire area subsequently buckled, dropping the ceiling about a foot. Halon concentration at the floor location reached 5 percent in about 30 seconds, and the gasoline fire was extinguished. The concentration of Halon reached a maximum level of only 5.7 percent at the floor location, and dropped to under 3.5 percent in 6 minutes. No Halon concentration was detected in the adjoining room.

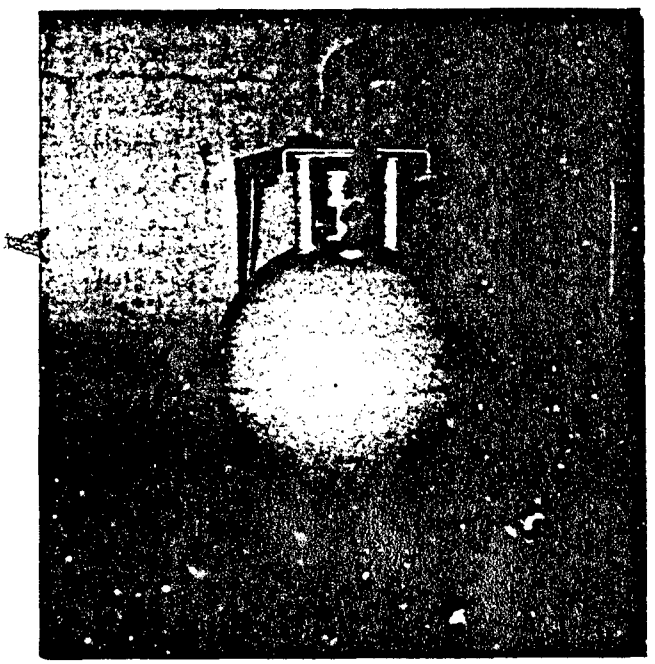

Figure 17. FENWAL Storage Container with Spiral Nozzle.

c. Test 3.

A new Halon container was installed in the support bracket and the discharge line was repiped so that the spiral discharge nozzle was approximately 2 feet below the ceiling. The door between the fire test room and adjoining room was left open and the opening was sealed with a transparent strip curtain door. A wood brand was installed on the fire test fixture and ignited.

The Halon agent was discharged approximately 30 seconds after activation of the alarm unit. While the Halon was being discharged from the container, a pipe union separated, dropping the piping and nozzle to the floor. The remaining agent from the container was then directed downward from the discharge valve.

The Halon concentration at the floor location rose to 6.4 percent in 30 seconds and extinguished the wood fire. Halon concentration increased to 8.6 percent at the floor location and 6.89 percent in the adjoining room. Maximum concentration at the ceiling location was under 4 percent.

2. ANSUL System

An ANSUL fire suppression system, consisting of two control units, a Halon container and initiator assembly were installed in the Fire Test Room and connected into the alarm relay (Monaco control unit) Figure 18. Three fire tests were then performed and data were recorded during alarm activation and after the discharge of the container. ANSUL fire suppression systems and parts lists are contained in Appendix E.

a. Test 1.

The Halon container was positioned and restrained in the corner of the Fire Test Room and the discharge piped vertically with a flexible hose and 1-inch pipe (Figure 19). A two-orifice radial flow nozzle was installed on the end of the pipe.

A metal waste container was then filled with 2000 feet of magnetic computer tape and placed in the Fire Test Room. The tape was then ignited, and the resulting smoke activated the alarm system. The Halon discharge valve opened approximately 12 seconds after the alarm activation.

Halon concentration at the floor sampling location rose to 5.8 percent in 30 seconds, extinguishing the flame. Halon concentration at the floor location rose to 9.26 percent and remained above 6.0 percent for 10 minutes. The magnetic tape continued to glow and produce smoke during the test and when the bucket was removed from the room, the remaining tape burst into flame. Halon concentration sampled in the adjoining room rose to a maximum of 6.66 percent and remained above 5 percent at the completion of the test.

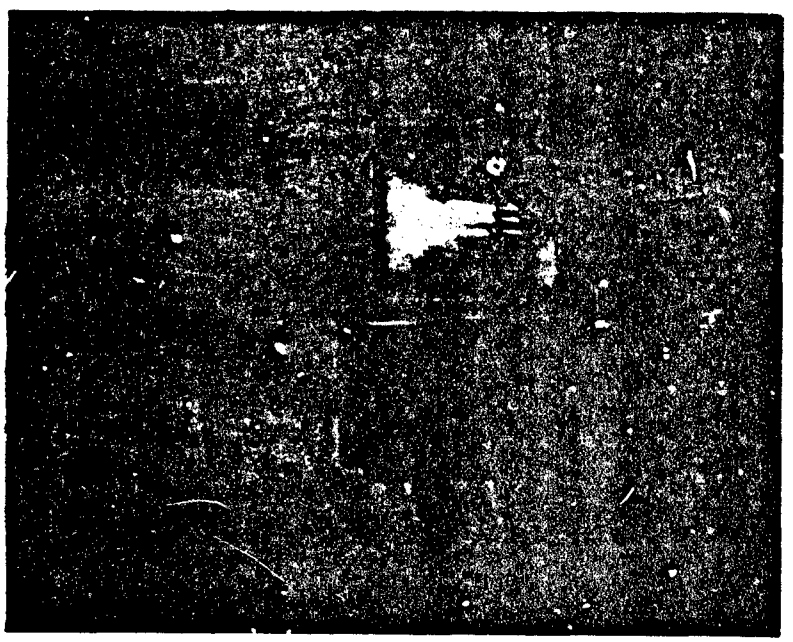

Figure 18. ANSUL Control Unit Connected to Monaco Alarm.

b. Test 2.

A new Halon container was installed and connected to the discharge piping. The entrance between the fire test room and adjoining room was protected by a strip-type curtain door.

A pan containing a small amount of gasoline was placed on the fire test fixture and ignited. The Halon agent was discharged approximately 12 seconds after activation of the alarm unit.

The Halon concentration at the floor location reached 6.74 percent in 30 seconds, and the fire was extinguished. Halon concentration remained above 6 percent at the floor location. Concentration at the ceiling rose to 5.7 percent in 1 minute, and the Halon concentration in the adjoining room reached a maximum of 6.9 percent.

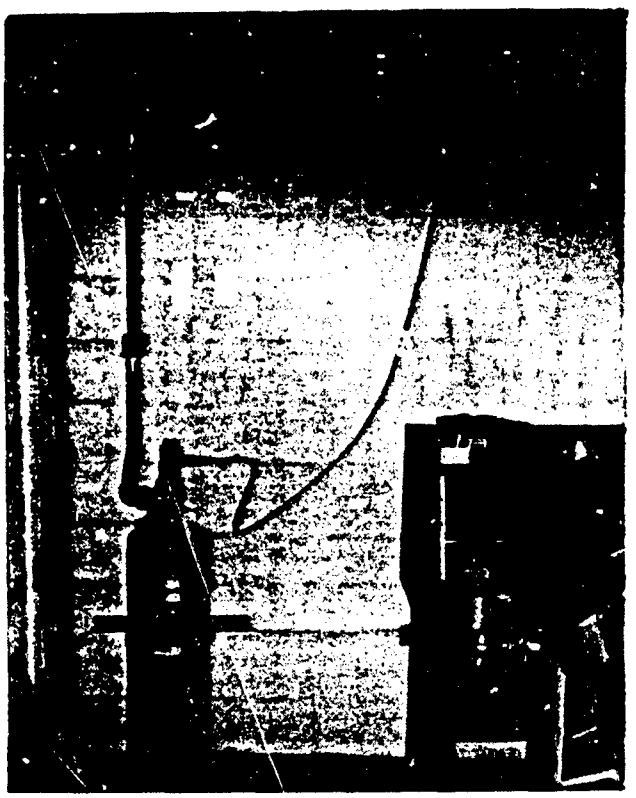

Figure 19. Storage Container Installation.

c. Test 3.

A new Halon container was then installed and connected to the discharge piping. The time delay on the control unit was reset for 30 seconds. One of the curtain doors separating the test room from the adjoining rooms was then removed.

The wire mesh container was filled with polystyrene packing material and placed on the fire test fixture.

The plastic was ignited, and the smoke buildup activated the alarm unit in approximately 1 minute. The Halon agent was released at approximately 30 seconds after the alarm. Halon concentration at the floor location increased to 6.74 percent in 30 seconds, extinguishing the fire. Concentrations at the floor location rose to 9.1 percent in 1 minute, and had only decreased to 7.8 percent in 7 minutes. Halon concentration in the adjoining room reached a maximum of 6.9 percent.

SECTION IV

TEST RESULTS

A. GENERAL

Installation of the Monaco detection/alarm system in the Fire Test Room was easily accomplished. Only minor modifications were required to the case of the control unit to provide for surface mounting brackets and wiring penetration.

Interconnection of the suppression release unit to the Monaco Control unit was readily accomplished by installing two wires which attached to the common and (normally open) dry type contacts of the control unit.

B. SMOKE TESTS

The Monaco detection/alarm unit responded satisfactorily to smoke obscuration produced by all control test fires, with the exception of the plastic fire, which failed to generate sufficient smoke before it self-extinguished.

During the paper fire tests (Table 1), the combustibles started to self-extinguish after approximately 90 seconds and had to be reignited. Approximately 30 seconds after reignition (120 seconds burning time), the reference smoke detector activated at a smoke obscuration of 0.20 percent per foot. After another 75 seconds, the Monaco detector activated at a smoke obscuration of 2.08 percent per foot.

Smoke generated by wood fires (Tables 2 and 3) activated the reference smoke detector after 45 seconds at smoke obscurations of 1.44 and 0.607 percent per foot, respectively. The Monaco detector activated after 60 seconds at a smoke obscuration of 4.85 percent per foot.

TABLE 1. PAPER FIRE TEST.

BURNING TIME (SECONDS)	METER READING (Ma)	LIGHT TRANSMISSION (PERCENT)	OBSCURATION PERCENT/FOOT	REF. SMOKE DETECTOR ON-OFF	MONACO SYSTEM ON-OFF	ALARM LEVEL dB(A)
0	.203	100	0.00	OFF	OFF	
15	.203	100	0.00	OFF	OFF	
30	.203	100	0.00	OFF	OFF	
45	.203	100	0.00	OFF	OFF	
60	.203	100	0.00	OFF	OFF	
75	.203	100	0.00	OFF	OFF	
90	.199	98	.43	OFF	OFF	
105	.203	100	0.00	OFF	OFF	
120	.201	99	.20	ON	OFF	
135	.199	98	.43		OFF	
150	.196	96	.813		OFF	
165	.193	95	1.02		OFF	
180	.184	90	2.08		OFF	
195	.183	90	2.08		ON	70
210	.180	88	2.52			
225	.183	90	2.08			
240	.176	86	2.97			

The gasoline fire activated the reference smoke detector after 15 seconds of burning, and the Monaco detector after 30 seconds. The detectors were activated at smoke obscurations of 2.5 and 6.36 percent per foot, respectively (Table 4).

Smoke from the polystyrene fire (Table 5) activated the reference smoke detector, but the smoke density never reached a level necessary for activation of the Monaco detector. Polystyrene test fires were used for the suppression system tests and during these tests, the smoke levels were sufficient to activate the Monaco detector at smoke obscurations of 2.58 percent per foot.

TABLE 2. WOOD FIRE TEST.

BURNING TIME (SECONDS)	METER READING (Ma)	LIGHT TRANSMISSION (PERCENT)	OBSCURATION PERCENT/FOOT	REF. SMOKE DETECTOR ON-OFF	MONACO SYSTEM ON-OFF	ALARM LEVEL dB(A)
0	.205	100	0.00	OFF	OFF	
15	.205	100	0.00	OFF	OFF	
30	.205	100	0.00	OFF	OFF	
45	.191	.93	1.44	ON	OFF	
60	.161	78	4.85	ON	ON	70
75	.135	66	7.84	ON	ON	
90	.086	42	16.50	ON	ON	
105	.075	36	18.51	ON	ON	
120	.072	36	18.51	ON	ON	
135	.073	35	19.23	ON	ON	
150	.062	30	21.40	ON	ON	
165	.056	27	23.30	ON	ON	
180	.055	26	23.62	ON	ON	
195	.05	24	24.83	ON	ON	
210	.047	23	25.47	ON	ON	
225	.047	23	25.47	ON	ON	
240	.046	22	26.20	ON	ON	

The audible signal (horn) sound level was measured during operation on AC power and then on the internal batteries. Maximum sound level on AC operation was 70 dB(A), and 66 dB(A) on battery power.

C. FIRE SUPPRESSION

The first test of the FENWAL system produced a fair dispersion of the agent within the test room and extinguished the fire within 30 seconds. After this initial peak, the Halon concentration dropped rapidly and fell to less than 4 percent after 8 minutes (Figure 20).

TABLE 3. WOOD FIRE TEST.
(BATTERY OPERATION)

BURNING TIME (SECONDS)	METER READING (Ma)	LIGHT TRANSMISSION (PERCENT)	OBSCURATION PERCENT/FOOT	REF. SMOKE DETECTOR ON-OFF	MONACO SYSTEM ON-OFF	ALARM LEVEL dB(A)
0	198	100	0.00	OFF	OFF	
15	197	99	0.201	OFF	OFF	
30	.197	99	0.201	OFF	OFF	
45	.191	97	0.607	ON	OFF	
60	.154	78	4.85	ON	ON	66
75	115	58	10.33	ON	ON	
90		DATA OUTPUT ERRATIC			ON	
105		RESET AND OUTPUT CORRECTED			ON	
120					ON	
135				ON	ON	
150	.035	18	29.03	ON		
165	.033	17	29.84	ON		
180	.031	16	30.69	ON		

Tests of the FENWAL system with a spiral type of nozzle were inconclusive, since the first trial diverted a large quantity of the agent into the void between the roof and panel ceiling. This resulted in a decrease of Halon at the floor sampling point, and no reading at the sampling point in the adjoining room (Figure 21). During the second trial with the spiral nozzle, the discharge line separated and the agent discharged directly downward from the container. This produced a high Halon concentration in the adjoining room and at the floor location (Figure 22).

The ANSUL suppression system produced consistent Halon concentrations within the test room and adjoining room (Figures 23 through 25) with maximum peaks of over 9 percent at the floor sampling point, and the Halon concentration also remained above 5 percent for over 11 minutes (Figure 23).

Halon concentrations in the adjoining room with the double-curtain door (Figure 21) were not significantly different than the concentrations with a single-curtain door (Figure 22).

TABLE 4. GASOLINE FIRE TEST.

BURNING TIME (SECONDS)	METER READING (Ma)	LIGHT TRANSMISSION (PERCENT)	OBSCURATION PERCENT/FOOT	REF. SMOKE DETECTOR ON-OFF	MONACO SYSTEM ON-OFF	ALARM LEVEL dB(A)
0	.205	100	0.00	OFF	OFF	
15	.184	88	2.50	ON	OFF	
30	.148	72	6.36	ON	ON	70
45	.088	43	15.53	ON	ON	
60	.068	33	19.09	ON	ON	
75	.039	19	28.25	ON	ON	
90	.042	20	27.49	ON	ON	
105	.031	15	31.57	ON	ON	
120	.028	14	32.51	ON	ON	
135	.022	11	35.69	ON	ON	
150	.020	10	36.90	ON	ON	
165	.017	8	38.88	ON	ON	
180	.013	6	43.03	ON	ON	

TABLE 5. POLYSTYRENE FIRE TEST.

BURNING TIME (SECONDS)	METER READING (Ma)	LIGHT TRANSMISSION (PERCENT)	OBSCURATION PERCENT/FOOT	REF. SMOKE DETECTOR ON-OFF	MONACO SYSTEM ON-OFF	ALARM LEVEL dB(A)
0	.195	100	0.00	OFF	OFF	
15	.195	100	0.00	OFF	OFF	
30	.181	93	1.44	ON	OFF	
45	.178	91	1.87	ON	OFF	
60	.163	83	3.66	ON	OFF	
75	.166	85	3.20	ON	OFF	
90	.175	89	2.30	ON	OFF	
105	.172	88	2.52	ON	OFF	
120	.172	88	2.52	ON	OFF	
135		MATERIAL CONSUMED			OFF	

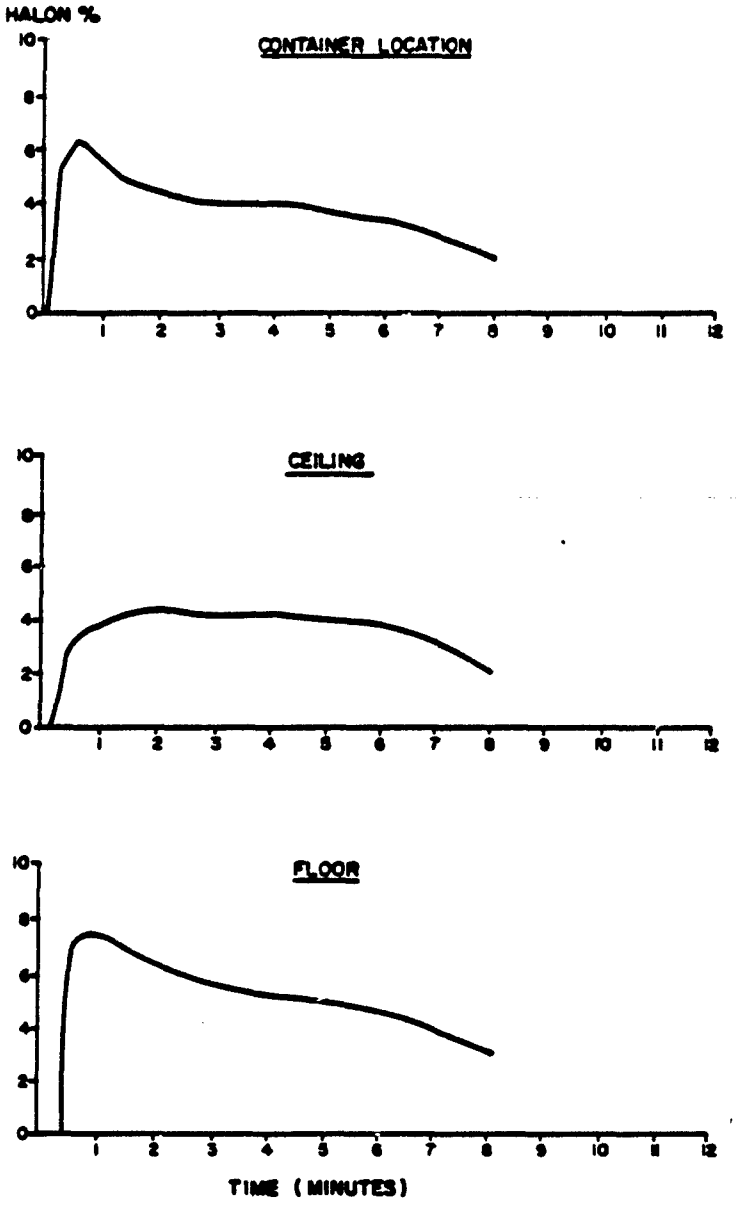

Figure 20. Halon Concentration vs Time FENWAL Test 1.

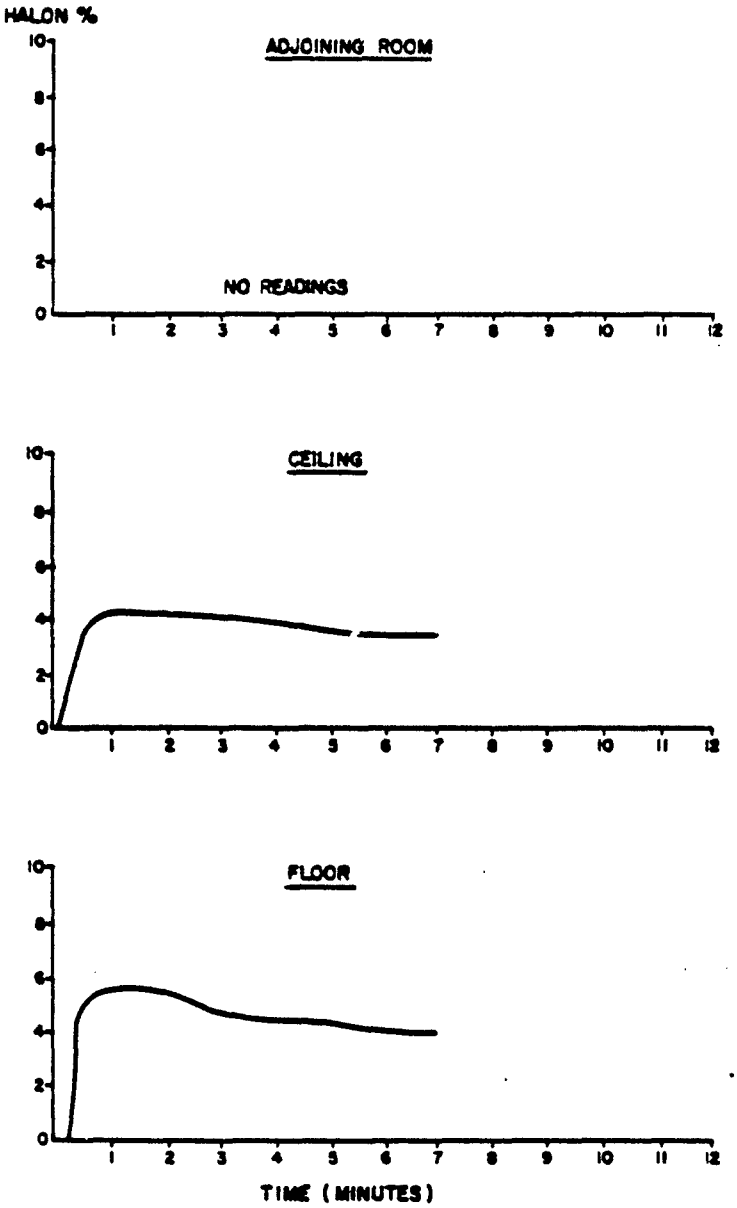

Figure 21. Halon Concentration vs Time
FENWAL Test 2.

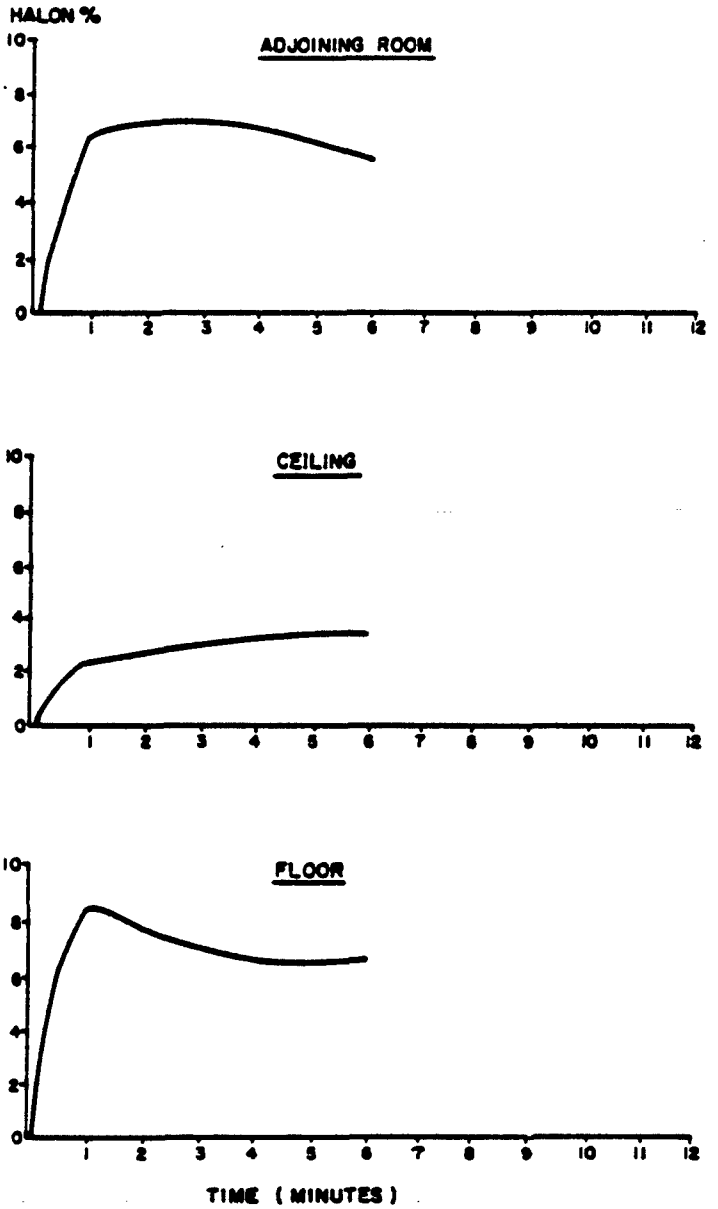

Figure 22. Halon Concentration vs Time
FENWAL Test 3.

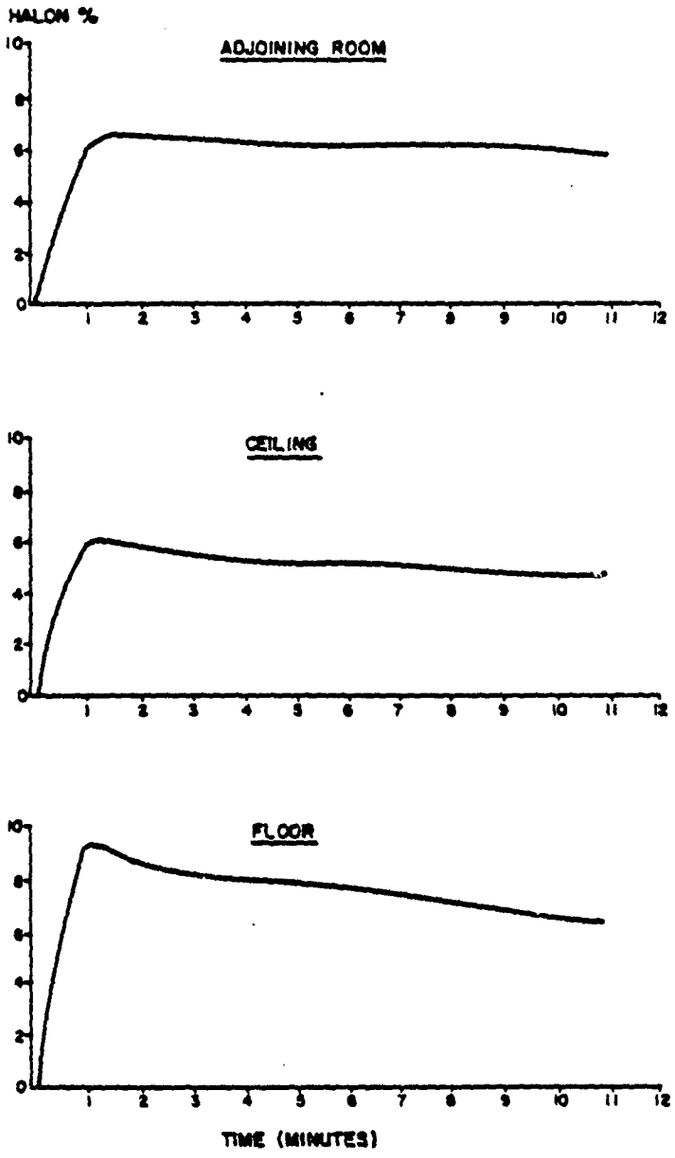

Figure 23. Halon Concentration vs Time
ANSUL Test 1.

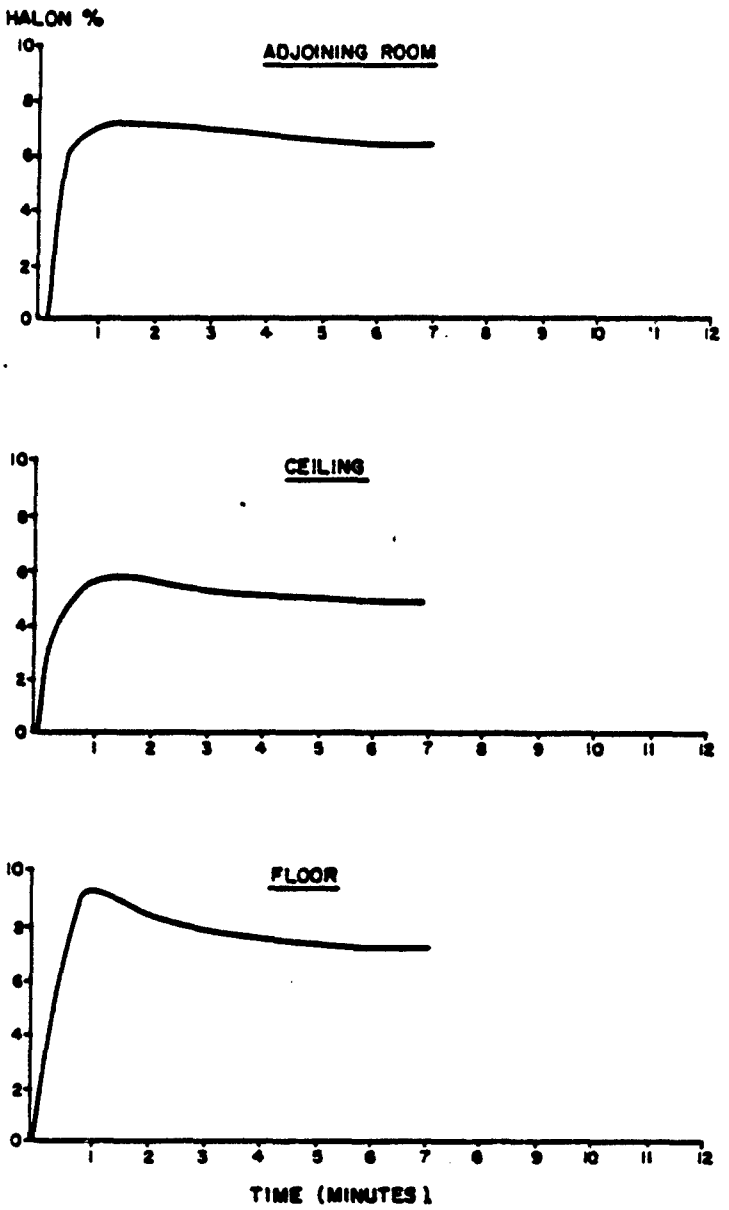

Figure 24. Halon Concentration vs Time
ANSUL Test 2.

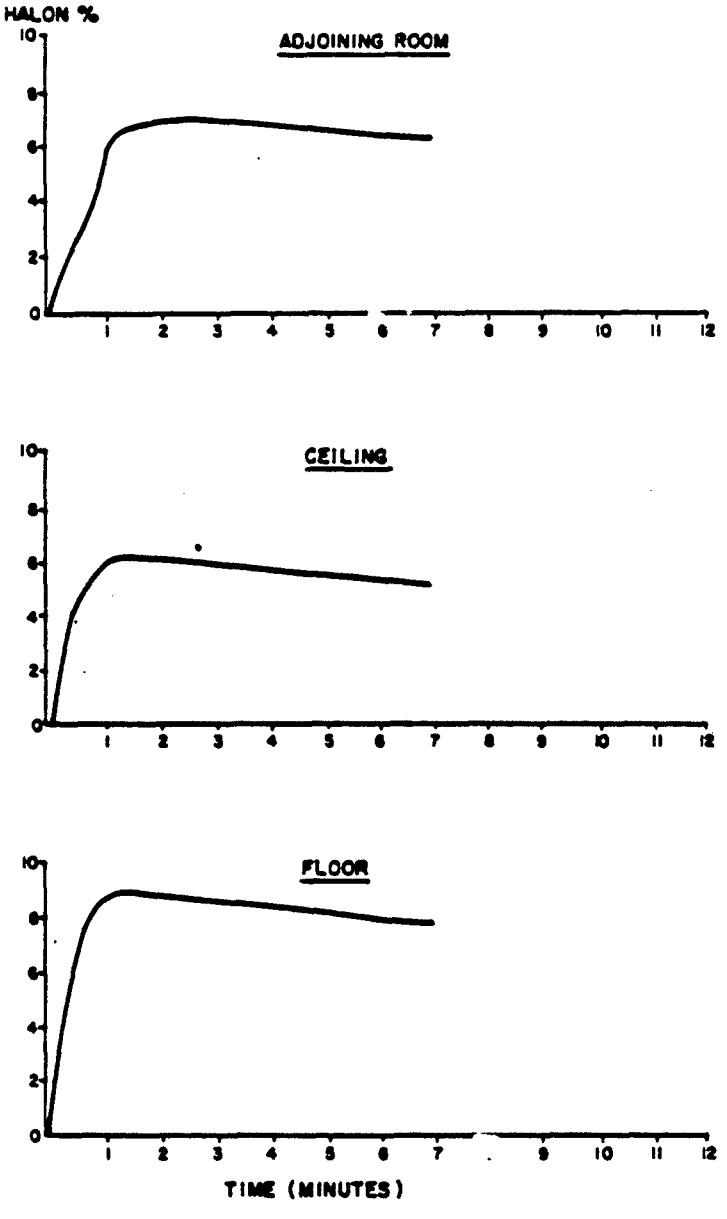

Figure 25. Halon Concentration vs Time
ANSUL Test 3.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

A. ALARM/DETECTION SYSTEM

The Monaco system performed satisfactorily and met the requirement of Underwriters' Laboratory Standard 268 and the National Fire Protection Association Standard 72E for automatic fire detectors. The alarm/detection system response to smoke obscuration and the sound level of the audible signaling device failed to achieve the levels specified in the Air Force Requirements Letter (Appendix B). Smoke obscurations required to activate the detector ranged from 2.0 to 6.3 percent per foot. Maximum output of the signaling device was 70 dB(A) at 100-foot radius and 66 dB(A) when operated on battery power.

Functional tests of the alarm/detection system are easily performed by depressing the push-to-test button on the detector or the test pushbutton in the control unit. While these features are assets for a detection/alarm system, they present a potential for inadvertently discharging an installed fire suppression system.

B. SUPPRESSION SYSTEMS

The two competitive fire suppression systems (FENWAL, ANSUL) were easily installed, and demonstrated adequate response and fire-extinguishing capability.

The FENWAL release unit contains all the necessary electronics for supervision, remote signaling equipment and release of the extinguishing agent. Also, the two cover-mounted switches enable the system to abort a discharge or to be manually released.

This release unit can, thus, be used as an alarm/detection system, and without any modification, can supply power for activation of a Halon discharge valve.

The ANSUL Halon container and discharge nozzle provided an easier installation and a better mixing of the discharge agent. Additionally, the larger quantity of agent (90 pounds) sustained the Halon concentration in the test room above 5 percent for an extended period.

The ANSUL storage container utilizes a pneumatically operated discharge valve, rather than the FENWAL explosive squib-operated type of valve to discharge the agent. The ANSUL valve configuration eliminates the handling and storage problems associated with squibs (explosive-charged actuator).

C. RECOMMENDATIONS

The following recommendations are submitted to improve the fire protection system.

1. Modify the requirement for the smoke detector to accept the smoke obscuration limits specified by Underwriters' Laboratory (0.5 to 4 percent for gray smoke, and 0.5 to 10 percent for black smoke) and the Air Force Fire Alarm Requirements (Appendix F).

2. Select a smoke detector that will operate from the control unit power and eliminate the integral push button.

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APPENDIX A

HALON REQUIREMENTS

APPENDIX A

MOBILE TACTICAL SHELTERS

HALON REQUIREMENTS FOR 5-PERCENT CONCENTRATION

$$W = \frac{V}{S}\left(\frac{C}{100-C}\right)$$

$$W = \frac{V}{S}\left(\frac{5}{100-5}\right)$$

$$S^{-40\ F} = 2.0016$$

$$S^{140\ F} = 2.9119$$

SHELTER TYPE	VOLUME (OUTSIDE CUBE)	HALON REQUIRED	AGENT
S250	200 ft³	-40°F 5.25 lb 140°F 3.61	12 lb
S280	675 ft³	-40°F 17.75 lb 140°F 12.19	18 lb
8x8x10 ISO	640 ft³	-40°F 16.82 lb 140°F 11.56	18 lb
8x8x20 ISO	1280 ft³	-40°F 33.64 lb 140°F 23.12	33 lb
8x8x20 ISO (Double-wide)	2560 ft³	-40°F 67.27 lb 140°F 46.24	68 lb
8x8x20 ISO (Triple-wide)	3840 ft³	-40°F 100.91 lb 140°F 69.36	50 lb ea
8x8x20 ISO (50ft Expandable)	7840 ft³	-40°F 200.02 lb 140°F 141.62	108 lb ea

APPENDIX B

TACTICAL SHELTER FIRE ALARM SYSTEM

APPENDIX B

TACTICAL SHELTER FIRE ALARM SYSTEM

A. GENERAL

This system shall protect an individual tactical shelter and contents from catastrophic damage as a result of fire. The system will detect the existence of fire and activate an audible alarm, both inside and outside of the shelter.

1. Operation

Operation of any automatic fire detection device shall result in the continuous ringing of all fire alarm devices.

2. General Requirements

Materials and equipment shall be new standard products of the manufacturer's latest design, and suitable to perform the functions intended. Where two or more pieces of equipment must perform the same functions, there shall be duplicates produced by one manufacturer. The name of the manufacturer and the serial numbers shall appear on all major components. Locks for all cabinets shall be keyed alike.

3. Quality Requirements

All materials and equipment shall conform to the requirements of the UL, or the FMS for fire-alarm systems of the type indicated. The Contractor shall submit proof that the items furnished under this specification conform to these requirements. The UL label or seal, or listing in the UL Fire Protection Equipment Directory, will be accepted as evidence that the items conform to UL requirements. The FMS label or seal, or listing in the Factory Mutual Approval Guide, will be accepted as sufficient evidence that the items conform to the FMS requirements.

B. ALARM EQUIPMENT

The exterior alarm equipment shall be audible at 100 feet (75 dBA) from the shelter.

C. FIRE-DETECTING EQUIPMENT

The fire-detecting equipment shall be of the following types: combination fixed-temperature rate-of-rise type or photoelectric type. Detector circuit design shall be suitable for the types and numbers of detectors, as approved, and shall limit detector circuit current not to exceed ratings of the detectors and associated relays. All detectors shall be UL-listed or FM-approved.

1. Photoelectric-Type Smoke Detectors

Ceiling or wall-mounted smoke detectors which operate on the light-scattering principle shall be furnished. Smoke entering the filtered chamber shall cause light from an internal source to be scattered into the chamber housing the photoelectric cell. The detector will register an alarm when the smoke obscuration of light is 2 percent per foot. The light source shall be a 200,000-hour light emitting diode. The detector shall contain two photoelectric cells, one for detection of smoke and another to be used as a reference to compensate for component aging and dust accumulation in the detector. The detector amplifiers and sensing circuits shall be exclusively solid state. Internal relays or solid-state switches shall provide trouble and alarm contacts for annunciation.

D. CONTROL UNIT

A control unit shall be installed as part of the system in each protected shelter, and shall be designed for use with the fire-detecting equipment and alarm-sound appliances. The control unit shall be housed in a substantial cabinet with lock and key. Metal cabinets shall be painted inside and out. The control unit shall include a suitable means for testing the system. The unit shall be arranged so as to operate the alarm device in the event of fire,

and to continue operation until silenced by a reset switch on the unit cabinet. Relays shall be of the plug-in type. Control unit shall be capable of supporting one to six detectors. Suitable connections shall be provided to allow interconnection with a standard fire alarm transmitter. Control unit shall be capable of vertical or horizontal mounting and whose dimensions do not exceed 6 inches by 6 inches by 3 inches.

E. POWER SUPPLY

1. Primary Power Supply

Primary power supply shall be a 115/120-volt, 50- or 60-cycle AC source. Rectifiers shall be of the solid-state type.

2. Standby Power Supply

Standby power supply that will ensure operation of all the fire-alarm devices within the protected shelter in the event of power failure shall be provided by a readily accessible commercially available battery. The transfer to battery shall be automatic upon failure of the primary power supply, and arranged so that there will be no drain on the battery except upon transfer and during a fire alarm. Battery shall have the capacity to operate the full system for not less than 8800 continuous hours, then power the alarms for 8 continuous hours. Restoration of primary power supply shall automatically disconnect the battery and reconnect the main supply.

F. STANDARD SYSTEM

A package system shall include:

1. Photoelectric Detector.

2. Control Unit.

3. Alarm Device.

4. Twenty feet - Detection Circuit Cable.

5. Ten Feet - Alarm Circuit Cable.

G. OPTIONAL FEATURES

Not required, but desirable and should be obtained if contractor can furnish.

1. Supervision of the controls and detector light source and sensing circuits - if a fault is detected, the alarm device will sound and a trouble indicator will illuminate on the control cabinet.

2. Low-battery power warning.

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APPENDIX C

TACTICAL SHELTER FIRE SUPPRESSION SYSTEM

APPENDIX C

TACTICAL SHELTER FIRE SUPPRESSION SYSTEM

A. GENERAL

This system shall protect an individual tactical shelter and contents from catastrophic damage as a result of fire. The system will suppress a fire within the shelter when a fire signal is received from the Tactical Shelter Fire Alarm System.

1. Operation

The suppression system will interconnect with the Tactical Shelter Fire Alarm System through a supervised circuit (the Tactical Shelter Fire Alarm provides an open/closed switch connection). Upon activation of the Tactical Shelter Fire Alarm System the system will begin a 30-second delay sequence (sequence will reset if the alarm signal is terminated) after which the extinguishing agent will be discharged. Operation of any automatic fire detection device shall result in the continuous ringing of all fire alarm devices.

2. General Requirements

Materials and equipment shall be new standard products of the manufacturer's latest design, and suitable to perform the functions intended. Where two or more pieces of equipment must perform the same functions, there shall be duplicates produced by one manufacturer. The name of the manufacturer and the serial numbers shall appear on all major components. Locks for all cabinets shall be keyed alike.

3. Quality Requirements

All materials and equipment shall conform to the requirements of the UL, or the FMS for fire suppression systems of the type indicated. The Contractor shall submit proof that the items furnished under this specification conform to these requirements. The UL label or seal, or listing in the UL Fire Protection Equipment Directory, will be accepted as evidence that the items conform to UL requirements. The FMS label or seal, or listing in the Factory Mutual Approval Guide, will be accepted as sufficient evidence that the items conform to the FMS requirements.

B. CONTROL UNIT

A control unit shall be installed as part of the system in each protected shelter, and shall be designed for use with the fire suppression equipment. The control unit shall be housed in a substantial cabinet with lock and key. Metal cabinets shall be painted inside and out. The control unit shall include a suitable means for testing the system. The unit shall be arranged so as to operate the alarm device in the event of fire and to continue operation until silenced by a reset switch on the unit cabinet. Relays shall be of the plug-in type. Control unit shall be capable of vertical or horizontal mounting and whose dimensions do not exceed 6 inches by 6 inches by 3 inches.

C. POWER SUPPLY

1. Primary Power Supply

Primary power supply shall be a 115/120-volt, 50- or 60-cycle AC source. Rectifiers shall be of the solid-state type.

2. Standby Power Supply

Standby power supply to ensure operation of all the fire-alarm devices within the protected shelter in the event of power failure shall be provided

by a readily accessible commercially available battery. The transfer to battery shall be automatic upon failure of the primary power supply and arranged so that there will be no drain on the battery except upon transfer and during a fire alarm. Battery shall have the capacity to operate the full system for not less than 8800 continuous hours, then power the discharge sequences 3 times. Restoration of primary power supply shall automatically disconnect the battery and reconnect the main supply. Standby power supply may be substituted for primary power supply if capable of 26,400 hours continuous.

D. STANDARD SYSTEM

A package system shall include:

1. Control Panel.

2. Extinguishing Agent Container.

3. Twenty feet - Detection Circuit Cable.

4. Ten feet - Discharge Circuit Cable.

E. FEATURES

1. Supervision of the controls, discharge circuit, and sensing circuits - if a fault is detected, the alarm device will sound and a trouble indicator will illuminate on the control cabinet.

2. Low-battery power warning.

3. Indicator lights.

4. Power (constant glow is primary power mode, flash in standby power mode).

a. Trouble.

b. Alarm (flash in delay, constant glow after discharge).

5. Switches.

a. Abort - Flashes trouble and alarm lights and stops delay sequence.

b. Manual operation (protected with cover and wire) immediate release of agent.

c. Test (inside cabinet).

d. Reset (inside cabinet).

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APPENDIX D

SYSTEM/PARTS LIST
FENWAL, INC.

APPENDIX D

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: S250

System No. 31-296204-001

Type of System: Fire Suppression

QUANTITY	PART NUMBER	DESCRIPTION
2	70-202003-001	IONIZATION DETECTOR
2	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
1	31-192007-250	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	29-115619-008	DISCHARGE NOZZLE
1	29-116985-018	ALARM HORN
10 lbs.	29-193533-003	HALON 1301
50'	14-GAUGE	WIRING
1-90, 2-6"	NIPPLES (1 1/2" -40 galv). 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: S250

System No. 31-296204-002

Type of System: Suppression System tied into an existing alarm panel other than FENWAL's

QUANTITY	PART NUMBER	DESCRIPTION
	30-202003-001	IONIZATION DETECTOR
	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
1	31-192007-250	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	29-115619-008	DISCHARGE NOZZLE
1	29-116985-018	ALARM HORN
10 lbs.	29-193533-003	HALON 1301
25'	14-GAUGE	WIRING
1-90, 2-6"	NIPPLES (1 1/2" -40 galv). 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: S250

System No. 31-296204-003

Type of System: Fire Alarm

QUANTITY	PART NUMBER	DESCRIPTION
1	70-202003-001	IONIZATION DETECTOR
1	70-201000-001	DETECTOR BASE
1	30-191062-002	CONTROL UNIT
	31-192007-	AGENT STORAGE CONTAINER*
	31-199932-004	INITIATOR*
	31-194019-001	MOUNTING BRACKET*
0	29-115619-	DISCHARGE NOZZLE*
1	29-116985-018	ALARM HORN
	29-193533-003	HALON 1301
25'	14-GAUGE	WIRING
0		DISCHARGE PIPING*

Conversion from a FENWAL Fire Alarm System to a FENWAL Suppression System requires the equipment highlighted by an asterisk (*). For quantities, see System No. 31-296204-001. For the conversion of the control unit, order the suppression control unit door only, Part No. 30-194002-001. One (1) additional ionization detector, Part No. 70-202003-001, and (1) additional detector base, Part No. 70-201000-001, are required.

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x10 ISO or S280

System No. 31-296205-001

Type of System: Fire Suppression

QUANTITY	PART NUMBER	DESCRIPTION
2	70-202003-001	IONIZATION DETECTOR
2	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
1	31-192007-000	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-008	DISCHARGE NOZZLE
1	29-116985-018	ALARM HORN
18 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x10 ISO or S280

System No. 31-296005-002

Type of System: Suppression System tied into an existing alarm panel other than FENWAL's

QUANTITY	PART NUMBER	DESCRIPTION
1	30-191062-001	CONTROL UNIT
1	31-192007-000	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-008	DISCHARGE NOZZLE
18 lbs.	29-193533-003	HALON 1301
50'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x10 ISO or S280

System No. 31-296205-003

Type of System: Fire Alarm

QUANTITY	PART NUMBER	DESCRIPTION
1	70-202003-001	IONIZATION DETECTOR
1	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
	31-192007-	AGENT STORAGE CONTAINER*
	31-199932-004	INITIATOR*
	31-194019-001	MOUNTING BRACKET*
	29-115619-	DISCHARGE NOZZLE*
1	29-116985-018	ALARM HORN
	29-193533-003	HALON 1301*
50'		WIRING
		DISCHARGE PIPING

Conversion from a FENWAL Fire Alarm System to a FENWAL Suppression System requires the equipment highlighted by an asterisk (*). For quantities, see System No. 31-296205-001. For the conversion of the control unit, order the suppression control unit door only, Part No. 30-194002-001. One (1) additional ionization detector, Part No. 70-202003-001, and (1) additional detector base, Part No. 70-201000-001, are required.

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (single-wide)

System No. 31-296206-00

Type of System: Fire Suppression

QUANTITY	PART NUMBER	DESCRIPTION
2	70-202003-001	IONIZATION DETECTOR
2	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
1	31-192007-201	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-008	DISCHARGE NOZZLE
1	29-116985-018	ALARM HORN
33 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (single-wide)

System No. 31-296206-002

Type of System: Suppression System tied into an existing alarm panel other than FENWAL's

QUANTITY	PART NUMBER	DESCRIPTION
1	30-191062-001	CONTROL UNIT
1	31-192007-201	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-007	DISCHARGE NOZZLE
33 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (single-wide)

System No. 31-296206-003

Type of System: Fire Alarm

QUANTITY	PART NUMBER	DESCRIPTION
1	70-202003-001	IONIZATION DETECTOR
1	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
	31-192007-	AGENT STORAGE CONTAINER*
	31-199932-004	INITIATOR*
	31-194010-001	MOUNTING BRACKET*
	29-115519-	DISCHARGE NOZZLE*
1	29-116985-018	ALARM HORN
	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
		DISCHARGE PIPING*

Conversion from a FENWAL Fire Alarm System to a FENWAL Suppression System requires the equipment highlighted by an asterisk (*). For quantities, see System No. 31-296206-001. For the conversion of the control unit, order the suppression control unit door only, Part No. 30-194002-001. One (1) additional ionization detector, Part No. 70-202003-001, and (1) additional detector base, Part No. 70-201000-001, are required.

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (double-wide)

System No. 31-296207-001

Type of System: Fire Suppression

QUANTITY	PART NUMBER	DESCRIPTION
2	70-202003-001	IONIZATION DETECTOR
2	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
1	31-192007-203	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-008	DISCHARGE NOZZLE
1	29-116985-018	ALARM HORN
68 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (double-wide)

System No. 31-296207-002

Type of System: Suppression System tied into an existing Fire Alarm other than FENWAL's

QUANTITY	PART NUMBER	DESCRIPTION
1	30-191062-001	CONTROL UNIT
1	31-192007-203	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-008	DISCHARGE NOZZLE
68 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (double-wide)

System No. 31-296207-003

Type of System: Fire Alarm

QUANTITY	PART NUMBER	DESCRIPTION
1	70-202003-001	IONIZATION DETECTOR
1	70-201000-001	DETECTOR BASE
1	30-191062-002	CONTROL UNIT
	31-192007-	AGENT STORAGE CONTAINER*
	31-199932-004	INITIATOR*
	31-194019-001	MOUNTING BRACKET*
	29-115619-	DISCHARGE NOZZLE*
1	29-116985-018	ALARM HORN
	29-193533-003	HALON 1301*
100'	14 GAUGE	WIRING CONDUIT
		DISCHARGE PIPING*

Conversion from a FENWAL Fire Alarm System to a FENWAL Suppression System requires the equipment highlighted by an asterisk (*). For quantities, see System No. 31-296207-001. For the conversion of the control unit, order the suppression control unit door only, Part No. 30-194002-001. One (1) additional ionization detector, Part No. 70-202003-001, and (1) additional detector base, Part No. 70-201000-001, are required.

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (triple-wide)

System No. 31-296208-001

Type of System: Fire Suppression

QUANTITY	PART NUMBER	DESCRIPTION
2	70-202003-001	IONIZATION DETECTOR
2	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
1	31-192007-203	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-008	DISCHARGE NOZZLE
1	29-116985-018	ALARM HORN
100 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (triple-wide)

System No. 31-296208-002

Type of System: Suppression System tied into an existing alarm panel other than FENWAL's

QUANTITY	PART NUMBER	DESCRIPTION
1	30-191062-001	CONTROL UNIT
1	31-192007-203	AGENT STORAGE CONTAINER
1	31-199932-004	INITIATOR
1	31-194019-001	MOUNTING BRACKET
1	29-115619-008	DISCHARGE NOZZLE
100 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 1-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (triple-wide)

System No. 31-296208-003

Type of System: Fire Alarm

QUANTITY	PART NUMBER	DESCRIPTION
1	70-202003-001	IONIZATION DETECTOR
1	70-201000-001	DETECTOR BASE
1	30-191062-002	CONTROL UNIT
	31-192007-	AGENT STORAGE CONTAINER*
	31-199932-004	INITIATOR*
	31-194019-001	MOUNTING BRACKET*
	29-115619-	DISCHARGE NOZZLE*
1	29-116985-018	ALARM HORN
	29-193533-003	HALON 1301*
100'	14-GAUGE	WIRING CONDUIT
		DISCHARGE PIPING*

Conversion from a FENWAL Fire Alarm System to a FENWAL Suppression System requires the equipment highlighted by an asterisk (*). For quantities, see System No. 31-296208-001. For the conversion of the control unit, order the suppression control unit door only, Part No. 30-194002-001. One (1) additional ionization detector, Part No. 70-202003-001, and (1) additional detector base, Part No. 70-201000-001, are required.

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (50' expandable)

System No. 31-296209-001

Type of System: Fire Suppression (Halon 1301)

QUANTITY	PART NUMBER	DESCRIPTION
2	70-202003-001	IONIZATION DETECTOR
2	70-201000-001	DETECTOR BASE
1	30-191062-001	CONTROL UNIT
2	31-192007-203	AGENT STORAGE CONTAINER
2	31-199932-004	INITIATOR
2	31-194019-001	MOUNTING BRACKET
2	29-115619-008	DISCHARGE NOZZLE
200 lbs.	29-193533-003	HALON 1301
1	29-116985-018	ALARM HORN
200'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 2-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (50' expandable)

System No. 31-296209-002

Type of System: Suppression System tied into an existing Fire Alarm Panel other than FENWAL's

QUANTITY	PART NUMBER	DESCRIPTION
1	30-191062-001	CONTROL UNIT
2	310192007-203	AGENT STORAGE CONTAINER
2	310199932-004	INITIATOR
2	310194019-001	MOUNTING BRACKET
2	29-115619-008	DISCHARGE NOZZLE
200 lbs.	29-193533-003	HALON 1301
100'	14-GAUGE	WIRING
1-90°, 2-6"	NIPPLES (1 1/2" -40 galv.) 2-UC	DISCHARGE PIPING

US AIR FORCE

MOBILE TACTICAL SHELTERS

PROTECTION SYSTEMS

Shelter: 8x8x20 ISO (50' expandable)

System No. 31-296209-003

Type of System: Fire Alarm

QUANTITY	PART NUMBER	DESCRIPTION
2	70-202003-001	IONIZATION DETECTOR
2	70-201000-001	DETECTOR BASE
1	30-191062-002	CONTROL UNIT
	31-192007-	AGENT STORAGE CONTAINER*
	31-199932-004	INITIATOR*
	31-194019-001	MOUNTING BRACKET*
	29-115619-	DISCHARGE NOZZLE*
1	29-116985-018	ALARM HORN
	29-193533-003	HALON 1301*
100'	14-GAUGE	WIRING
		DISCHARGE PIPING*

Conversion from a FENWAL Fire Alarm System to a FENWAL Suppression System requires the equipment highlighted by an asterisk (*). For quantities, see System No. 31-296209-001. For the conversion of the control unit, order the suppression control unit door only, Part No. 30-194002-001. One (1) additional ionization detector, Part No. 70-202003-001, and (1) additional detector base, Part No. 70-201000-001, are required.

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APPENDIX E

SYSTEM/PARTS LIST

ANSUL FIRE PROTECTION, INC.

APPENDIX E

MODULAR PART NUMBERS U.S.A.F. TAC SHELTER

PART NUMBER	DESCRIPTION
74429	CHECKFIRE II (MODIFIED) HALON 12 LB SYSTEM
74430	CHECKFIRE II (MODIFIED) HALON 18 LB SYSTEM
74431	CHECKFIRE II (MODIFIED) HALON 33 LB SYSTEM
74432	CHECKFIRE II (MODIFIED) HALON 68 LB SYSTEM
74433	CHECKFIRE II (MODIFIED) HALON 100 LB SYSTEM
74434	CHECKFIRE II (MODIFIED) HALON 216 LB SYSTEM

CHECKFIRE II (MODIFIED) HALON 12 LB SYSTEM

PART NUMBER 74429

PART NUMBER 74429 WILL CONSIST OF THE FOLLOWING:

PART NUMBER	QTY	DESCRIPTION
74225	1	CHECKFIRE II CONTROL ASSEMBLY (MODIFIED)
70887	1	ELVA 12VDC ACTUATOR
32240	1	HALON 1301 TANK 12 LB AGENT, 18 LB TANK
57698	1	BRACKET TANK 18 LB
68677	1	NOZZLE 1", 2 ORIFICE
32333	1	UNION ELBOW 1"
68723	1	DISCHARGE HOSE 1", 18" LONG
13360	1	PIPE COUPLING 1"
74426	2	WALL BRACKET (PIPE) MOUNTING
74428	1	1" X 41.2" PIPE BLACK

CHECKFIRE II (MODIFIED) HALON 18 LB SYSTEM

PART NUMBER 74430

PART NUMBER 74430 WILL CONSIST OF THE FOLLOWING:

PART NUMBER	QTY	DESCRIPTION
74225	1	CHECKFIRE II CONTROL ASSEMBLY (MODIFIED)
70887	1	ELVA 12VDC ACTUATOR
32243	1	HALON 13C1 TANK 18 LB AGENT
57698	1	BRACKET TANK 18 LB
68677	1	NOZZLE 1", 2 ORIFICE
32333	1	UNION ELBOW 1"
68723	1	DISCHARGE HOSE 1", 18" LONG
13360	1	PIPE COUPLING 1"
74426	2	WALL BRACKET (PIPE) MOUNTING
74428	1	1" X 41.2" PIPE BLACK

CHECKFIRE II (MODIFIED) HALON 33 LB SYSTEM

PART NUMBER 74431

PART NUMBER 74431 WILL CONSIST OF THE FOLLOWING:

PART NUMBER	QTY	DESCRIPTION
74225	1	CHECKFIRE II CONTROL ASSEMBLY (MODIFIED)
70887	1	ELVA 12VDC ACTUATOR
32268	1	HALON 1301 TANK 33 LB AGENT, 33 LB TANK
57699	1	BRACKET TANK 33 LB
68677	1	NOZZLE 1", 2 ORIFICE
32333	1	UNION ELBOW 1"
68723	1	DISCHARGE HOSE 1", 18" LONG
13360	1	PIPE COUPLING 1"
74426	2	WALL BRACKET (PIPE) MOUNTING
74428	1	1" X 41.2" PIPE BLACK

CHECKFIRE II (MODIFIED) HALON 68 LB SYSTEM

PART NUMBER 74432

PART NUMBER 74432 WILL CONSIST OF THE FOLLOWING:

PART NUMBER	QTY	DESCRIPTION
74225	1	CHECKFIRE II CONTROL ASSEMBLY (MODIFIED)
70887	1	ELVA 12VDC ACTUATOR
32279	1	HALON 1301 TANK 68 LB AGENT, 72 LB TANK
57700	1	BRACKET TANK 72 LB
68677	1	NOZZLE 1", 2 ORIFICE
32333	1	UNION ELBOW 1"
68723	1	DISCHARGE HOSE 1", 18" LONG
13360	1	PIPE COUPLING 1"
74426	2	WALL BRACKET (PIPE) MOUNTING
74427	1	1" X 31.7" PIPE BLACK

CHECKFIRE II (MODIFIED) HALON 100 LB SYSTEM

PART NUMBER 74433

PART NUMBER 74433 WILL CONSIST OF THE FOLLOWING:

PART NUMBER	QTY	DESCRIPTION
74225	1	CHECKFIRE II CONTROL ASSEMBLY (MODIFIED)
70887	1	ELVA 12VDC ACTUATOR
32274	1	HALON 1301 TANK 50 LB AGENT, 54 LB TANK
57699	1	BRACKET TANK 54 LB
68677	1	NOZZLE 1", 2 ORIFICE
32333	1	UNION ELBOW 1"
68723	1	DISCHARGE HOSE 1", 18" LONG
13360	1	PIPE COUPLING 1"
74426	2	WALL BRACKET (PIPE) MOUNTING
74427	1	1" X 31.7" PIPE BLACK

CHECKFIRE II (MODIFIED) HALON 216 LB SYSTEM

PART NUMBER 74434

PART NUMBER 74434 WILL CONSIST OF THE FOLLOWING:

PART NUMBER	QTY	DESCRIPTION
74225	2	CHECKFIRE II CONTROL ASSEMBLY (MODIFIED)
70887	2	ELVA 12VDC ACTUATOR
32305	2	HALON 1301 TANK 108 LB AGENT, 186 LB TANK
57701	2	BRACKET TANK 186 LB
68677	2	NOZZLE 1", 2 ORIFICE
32333	2	UNION ELBOW 1"
68723	2	DISCHARGE HOSE 1", 18" LONG
13360	2	PIPE COUPLING 1"
74426	4	WALL BRACKET (PIPE) MOUNTING
74435	2	1" X 15.7" PIPE BLACK

TAC SHELTER PART NUMBERS

PART NUMBER	DESCRIPTION
74225	CHECKFIRE II CONTROL (ASSEMBLY FOR SHELTER)
70887	ELVA 12VDC ACTUATOR
32240	HALON 1301 TANK 12 LB AGENT, 18 LB TANK SIZE
57698	BRACKET TANK 18 LB
32243	HALON 1301 TANK 18 LB AGENT, 18 LB TANK SIZE
32268	HALON 1301 TANK 33 LB AGENT, 33 LB TANK SIZE
57699	BRACKET TANK 33 LB
32274	HALON 1301 TANK 50 LB AGENT, 54 LB TANK SIZE
57699	BRACKET TANK 54 LB
32279	HALON 1301 TANK 68 LB AGENT, 72 LB TANK SIZE
57700	BRACKET TANK 72 LB
32305	HALON 1301 TANK 108 LB AGENT, 186 LB TANK SIZE
57701	BRACKET TANK 186 LB
68677	NOZZLE 1 INCH, 2 ORIFICE
32333	UNION ELBOW 1 INCH
68723	DISCHARGE HOSE 1 INCH, 18 INCHES LONG
13360	PIPE COUPLING 1"
74426	WALL BRACKET (PIPE) MOUNTING
74435	1" X 15.7" PIPE BLACK
74427	1" X 31.7" PIPE BLACK
74428	1" X 41.2" PIPE BLACK

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APPENDIX F

TACTICAL SHELTER FIRE ALARM SYSTEM

APPENDIX F

TACTICAL SHELTER FIRE ALARM SYSTEM (REV. A)

A. GENERAL

This system shall protect an individual tactical shelter and contents from catastrophic damage as a result of fire. The system will detect the existence of fire and activate an audible alarm, both inside and outside of the shelter.

1. Operation

Operation of any automatic fire detection device shall result in the continuous ringing of all fire alarm devices.

2. General Requirements

Materials and equipment shall be new standard products of the manufacturer's latest design, and suitable to perform the functions intended. Where two or more pieces of equipment must perform the same functions, there shall be duplicates produced by one manufacturer. The name of the manufacturer and the serial numbers shall appear on all major components. Locks for all cabinets shall be keyed alike.

3. Quality Requirements

All materials and equipment shall conform to the requirements of the UL, or the FMS for fire-alarm systems of the type indicated. The Contractor shall submit proof that the items furnished under this specification conform to these requirements. The UL label or seal, or listing in the UL Fire Protection Equipment Directory, will be accepted as evidence that the items conform to UL requirements. The FMS label or seal, or listing in the Factory Mutual Approval Guide, will be accepted as sufficient evidence that the items conform to the FMS requirements.

B. ALARM EQUIPMENT

The exterior alarm equipment shall be audible at 100 feet (70 dBA) from the shelter.

C. FIRE-DETECTING EQUIPMENT

The fire-detecting equipment shall be of the following types: combination fixed-temperature rate-of-rise type or photoelectric type. Detector circuit design shall be suitable for the types and numbers of detectors, as approved, and shall limit detector circuit current not to exceed ratings of the detectors and associated relays. All detectors shall be UL listed or FM approved.

D. CONTROL UNIT

A control unit shall be installed as part of the system in each protected shelter and shall be designed for use with the fire-alarm equipment. The control unit shall be housed in a substantial cabinet with lock and key. Metal cabinets shall be painted inside and out. The control unit shall include a suitable means for testing the system. The unit shall be arranged so as to operate the alarm device in the event of fire and to continue operation until silenced by a reset switch on the unit cabinet. Relays shall be of the plug-in type. Control unit shall be capable of supporting a minimum of two detectors. Control unit shall be capable of vertical or horizontal mounting and whose dimensions do not exceed 6 inches by 6 inches by 3 inches.

E. POWER SUPPLY

1. Primary Power Supply

Primary power supply shall be a 115/120-volt, 50- or 60-cycle AC source. Rectifiers shall be of the solid-state type.

2. Standby Power Supply

Standby power supply that will ensure operation of all the fire-alarm devices within the protected shelter in the event of power failure shall be provided by a readily accessible commercially available battery. The transfer to battery shall be automatic upon failure of the primary power supply and arranged so that there will be no drain on the battery except upon transfer and during a fire alarm. Battery shall be able to operate the full system for not less than 8800 continuous hours, then power the alarm for 6 hours. Restoration of primary power supply shall automatically disconnect the battery and reconnect the main supply. Standby power supply may be substituted for primary power supply if capable of 26,400 continuous hours.

F. STANDARD SYSTEM

A package system shall include:

1. Control Unit.

2. Ionization Detector.

3. Twenty feet - Detection Circuit Cable.

4. Alarm Device.

5. Ten feet - Alarm Circuit Cable.

G. FEATURES

The following features will be available:

1. Supervision of the controls, detectors, alarm circuit, and sensing circuits - if a fault is detected, the alarm device will sound and a trouble indicator will illuminate on the control cabinet.

2. Low battery power warning.

3. Indicator lights.

4. Power (constant glow is primary power mode, flash in standby power mode).

   a. Trouble.

   b. Alarm discharge.

5. Switches.

   a. Test (inside cabinet).

   b. Reset (inside cabinet).

H. TERMINALS

Contact terminal shall be provided which provides for either an open or closed switch to permit interconnection with other devices.

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